SWAT model as a part of the integrated monitoring and modeling system for the Goczalkowice Reservoir basin

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POLISH-NORWEGIAN RESEARCH PROGRAMME

norway grants

Narodowe Centrum Badań i Rozwoju

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INSTITUTE OF ENVIRONMENTAL PROTECTION – NATIONAL RESEARCH INSTITUTE

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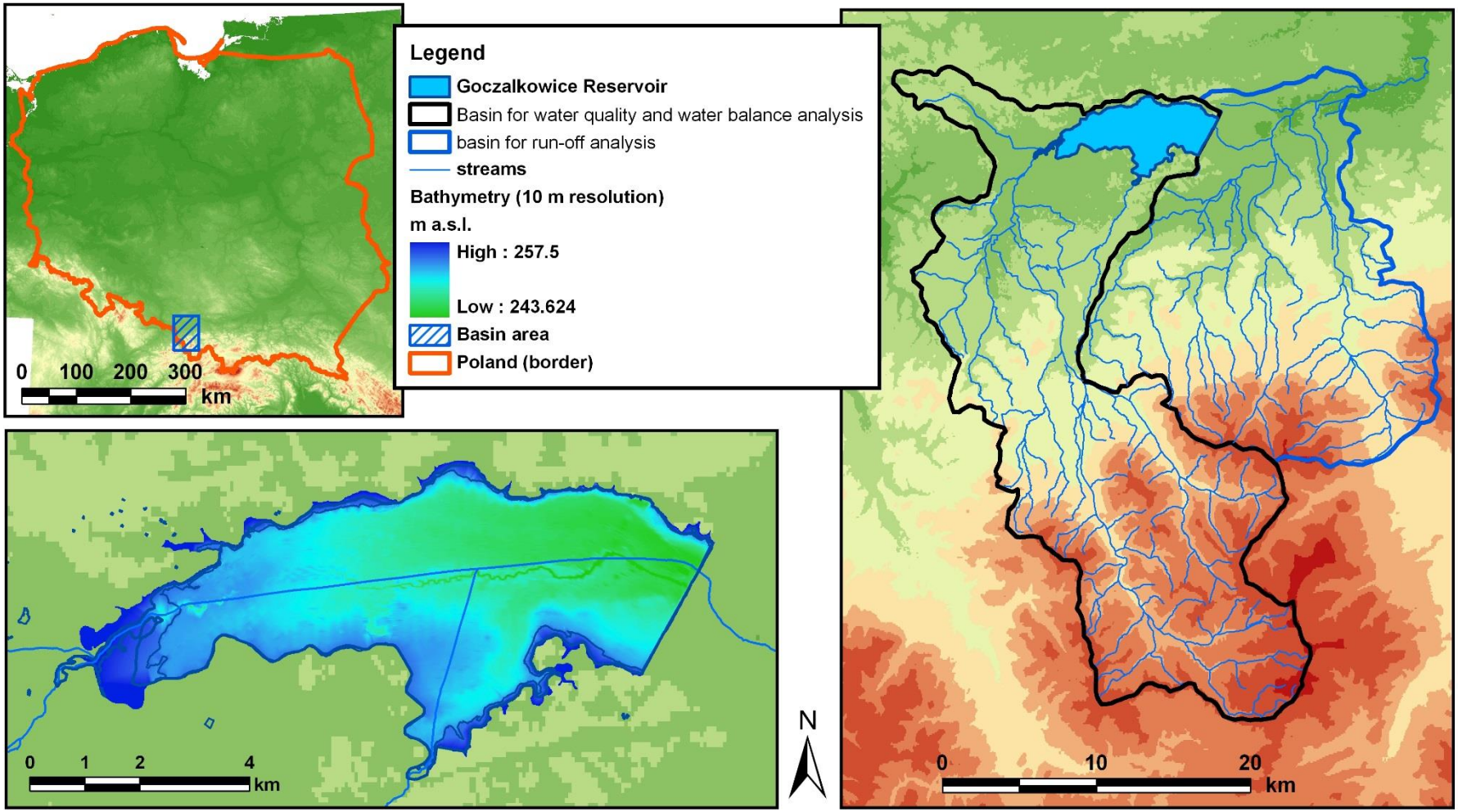
CRIS project – Study area

Mala Wisla river basin including:

- Goczalkowice dammed reservoir (32 km^2)
- 530 km^2 upstream the reservoir
- 379 km^2 downstream the reservoir



CRIS project – The goal

To develop the Complex River basin Information System (CRIS) supporting the river basin management in a context of the Water Framework Directive implementation.

The aim of information system is to support units responsible for water management, providing them with the information on:

- detailed real-time distribution of the precipitation (with short-term forecasts),
- real-time and forecasted flow rate and water level in streams,
- water quality status (with short forecasts),
- threats to the water resources,
- how different river basin scenarios can affect the water balance and water quality.

The project should be considered as a demonstration of the online support system for the water resources management which can be applied to other river basins.

CRIS project – The concept

Modelling module:

- **Simulation of the meteorological parameters** (Weather Research and Forecasting model – WRF)
- **Simulation of the atmospheric nitrogen deposition** (CALifornia PUFF model – CALPUFF)
- **Simulation of surface water balance and quality** (Soil and water Assessment Tool – SWAT)
- **Simulation of surface water flow rate and stage** (Hydrologic Engineering Center Hydrologic Modelling System /River Analysis System – HEC-HMS / HEC-RAS)
- **Simulation of Goczalkowice Reservoir hydrodynamics and water quality** (Generalized Environmental Modelling System for Surface waters - GEMSS)
- **Simulation of groundwater flow and quality** (Modular. Finite-Difference Ground-Water Flow Model - MODFLOW)

Data module:

- **Static spatial data:** elevation models, topography, hydrography, land use, soil maps, geological / hydrogeological maps etc.
- **Monitoring data:** meteorological data, flow gauges, water quality data, water intakes and discharges, etc.
- **Alternative data sources:** mainly satellite data, e.g. soil moisture, leaf area index, chlorophyll in surface waters

Archival data, real-time and short forecast

Models' inputs

Project database:

- **Data storage system** (MS SQL Server + ArcGIS)
- **Data transformation services** (exchange data between monitoring systems, database, models and user interfaces)

Online graphical user interface for information services (mapping of monitoring and modelling results, data tables, graphs)

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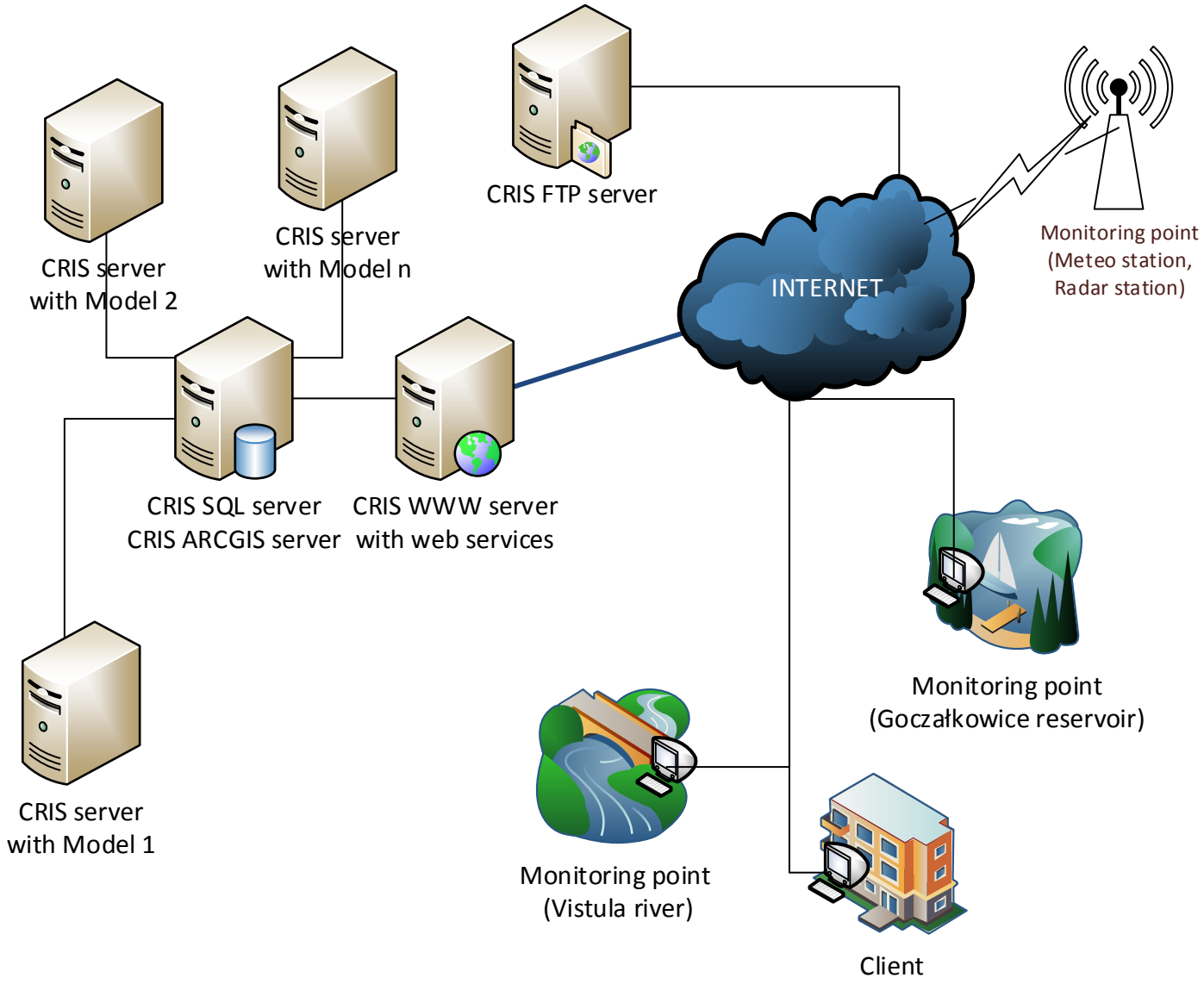
CRIS project – IT system

- Database already prepared and linked to monitoring systems
- Each model has dedicated virtual server
- GUI prepared and waiting for models outputs

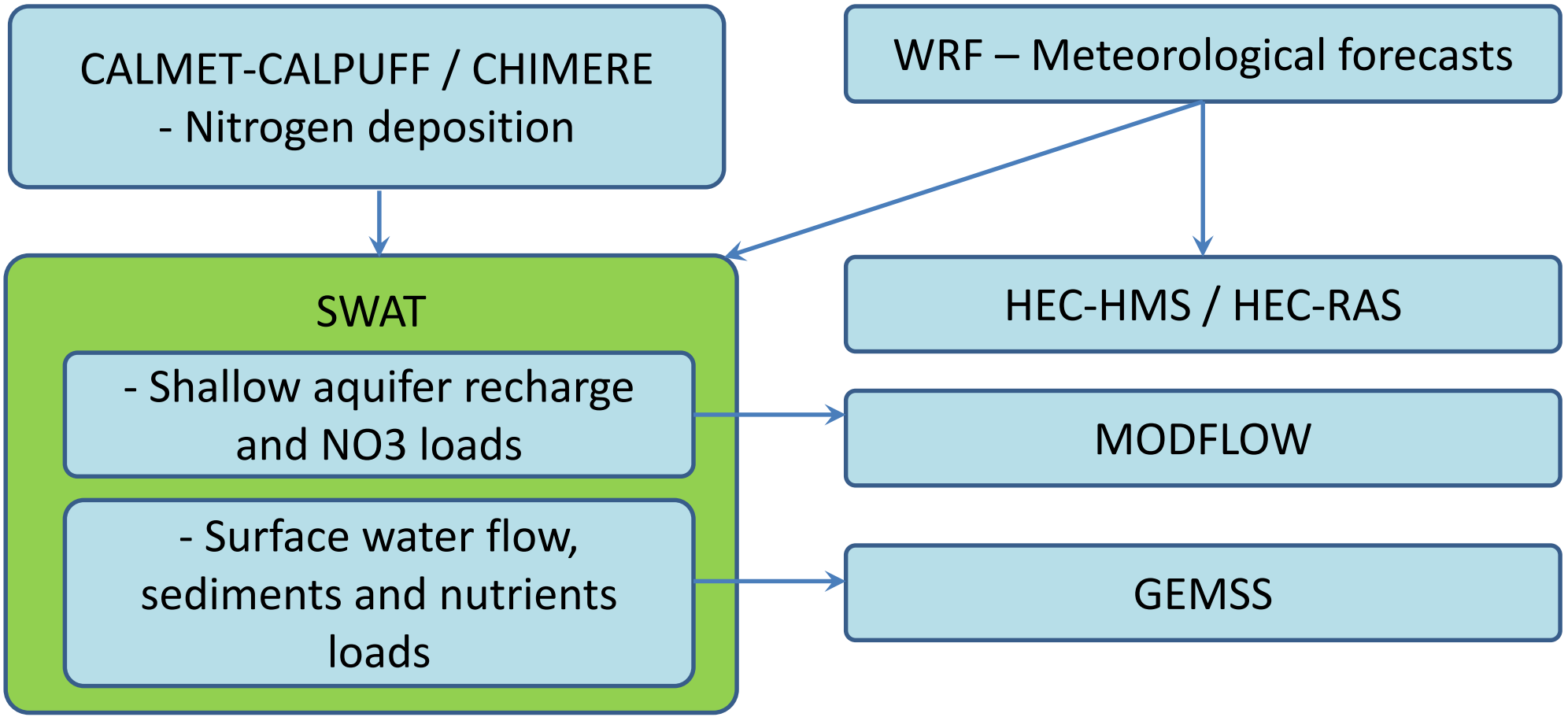


SWAT – Aims

Aims of the SWAT model:

- Provide daily information on surface water balance in the area upstream the Goczalkowice Reservoir
- Provide daily information on nutrients in surface waters
- Provide inputs to the MODFLOW model regarding groundwater recharge and nitrogen loads
- Provide inputs to the GEMSS model regarding inflows to the Goczalkowice Reservoir and loads of sediments and nutrients

SWAT – Data flow



SWAT – Basins and models

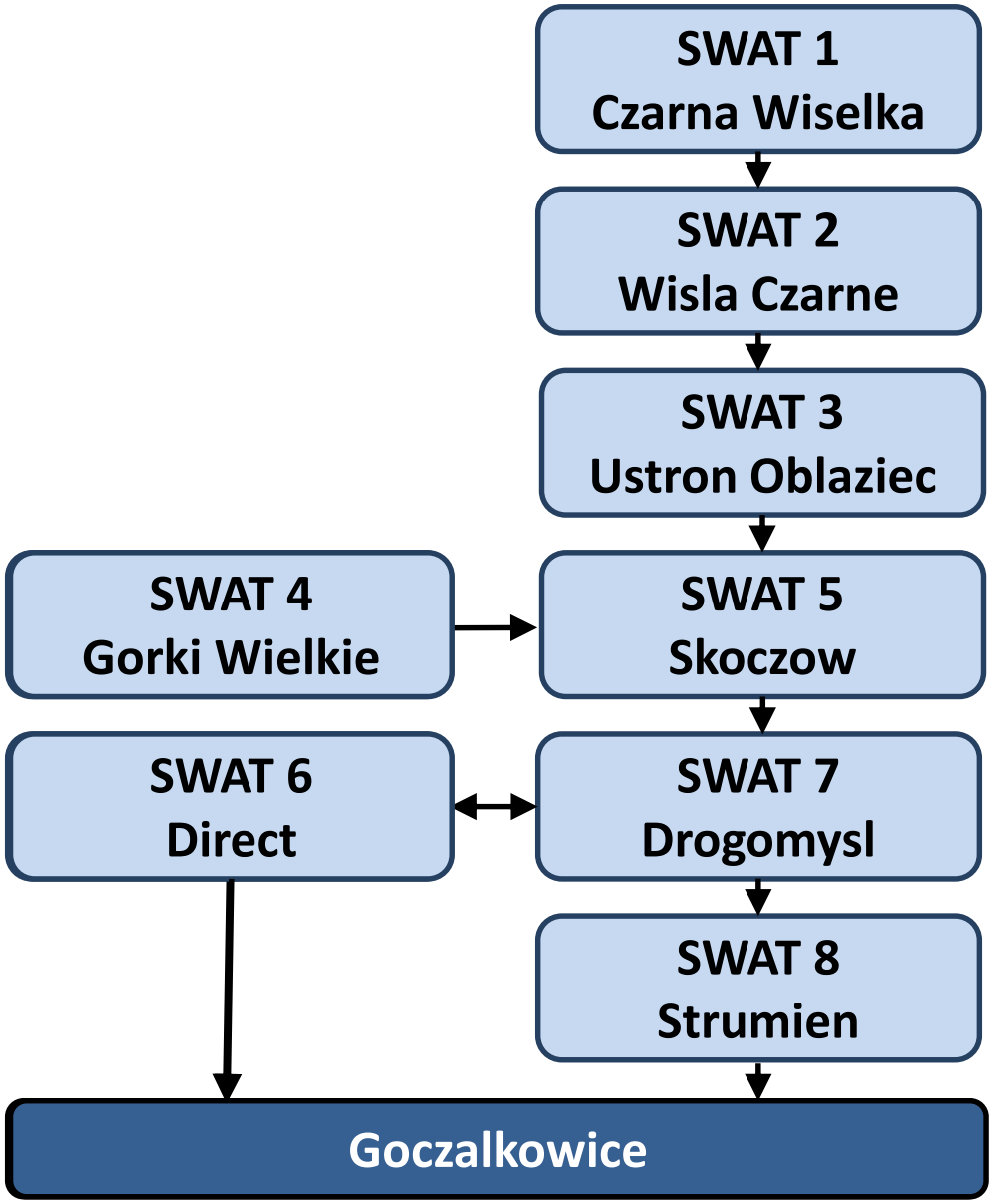
8 main basins and models

Principles of the division:

- 1 basins directly contributing to the reservoir with no flow gauge
- 1 basin directly contributing to the reservoir with a flow gauge
- 6 basins upstream; closed with a flow gauge

Links to other basins:

- 3 basins with no inlet discharges
- 5 basins with constant inlet discharge(s)
- 1 basin with seasonal inlet discharge



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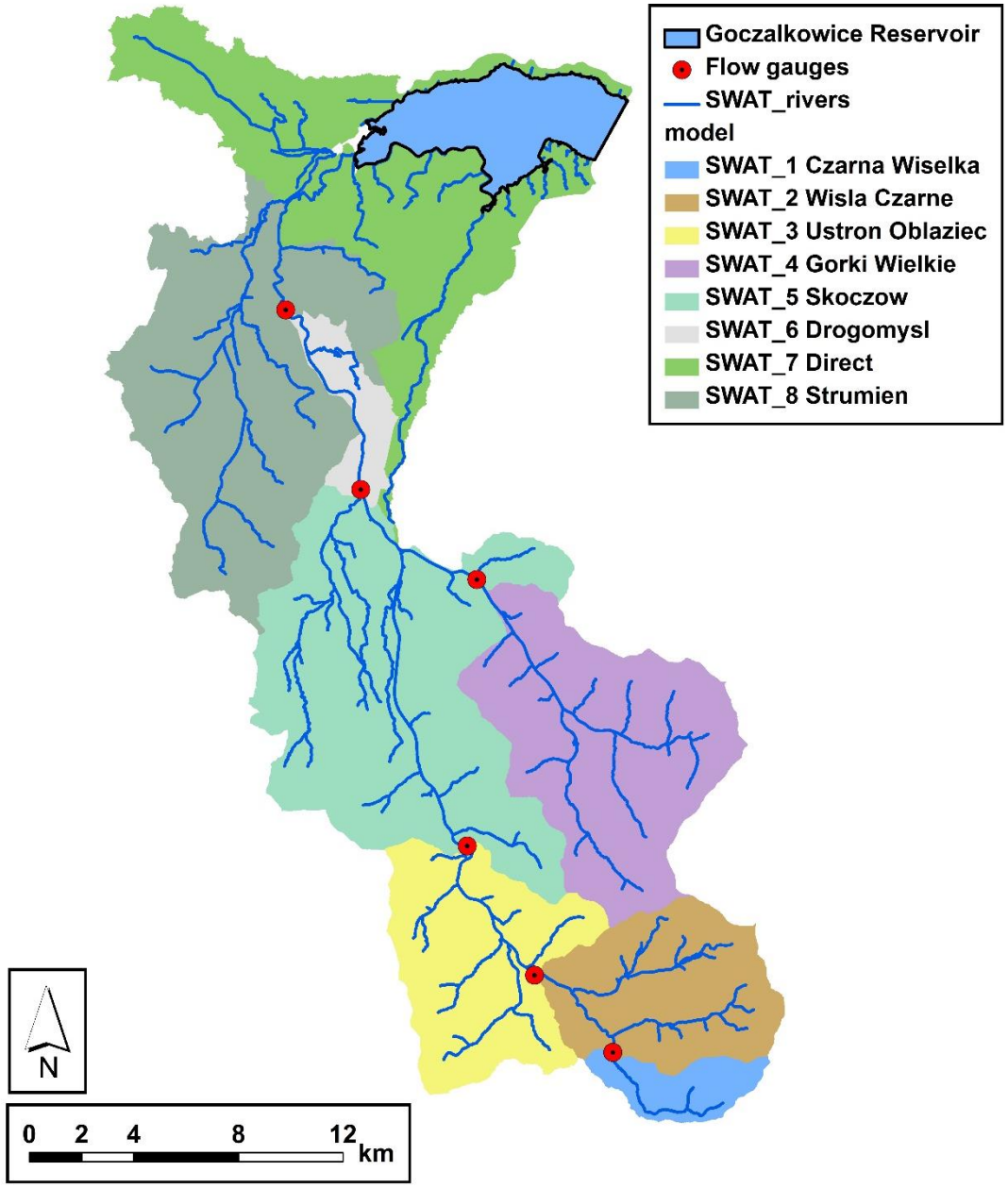
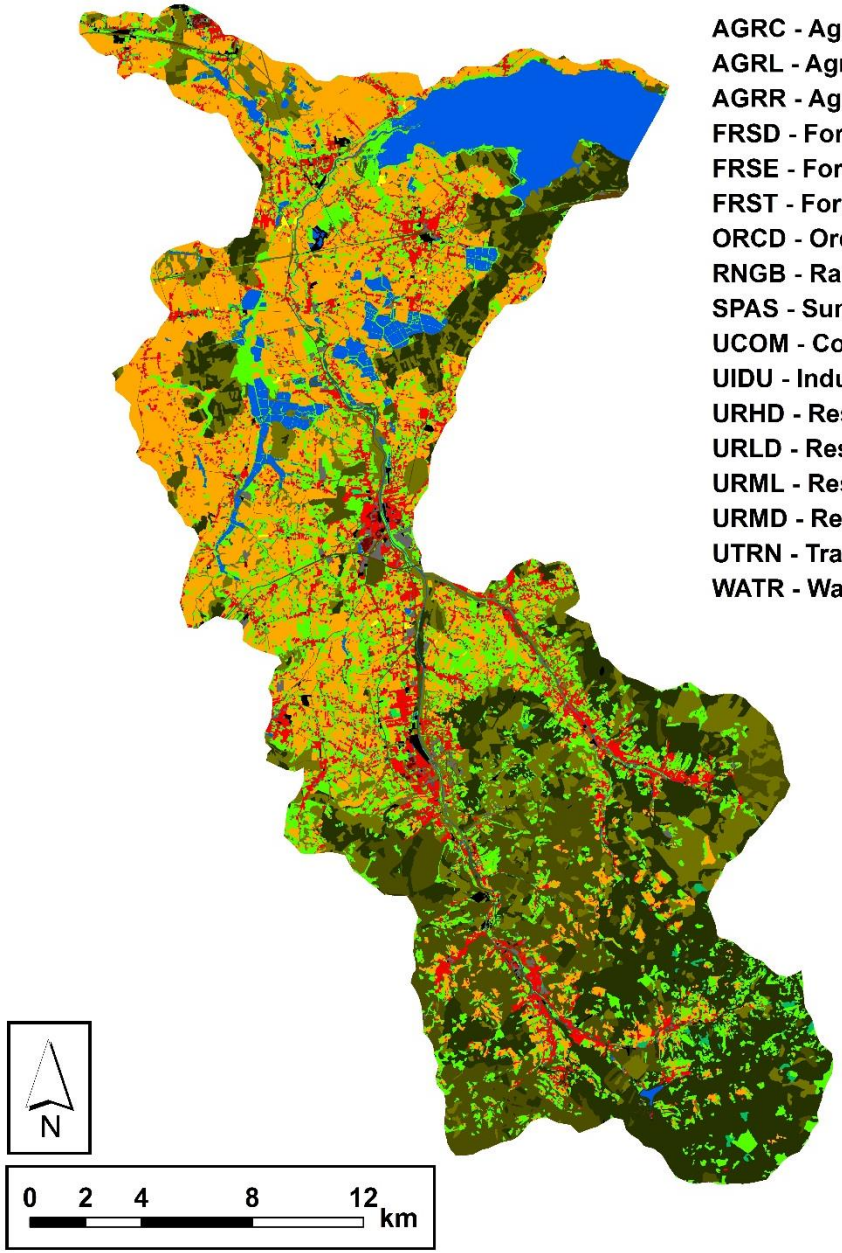
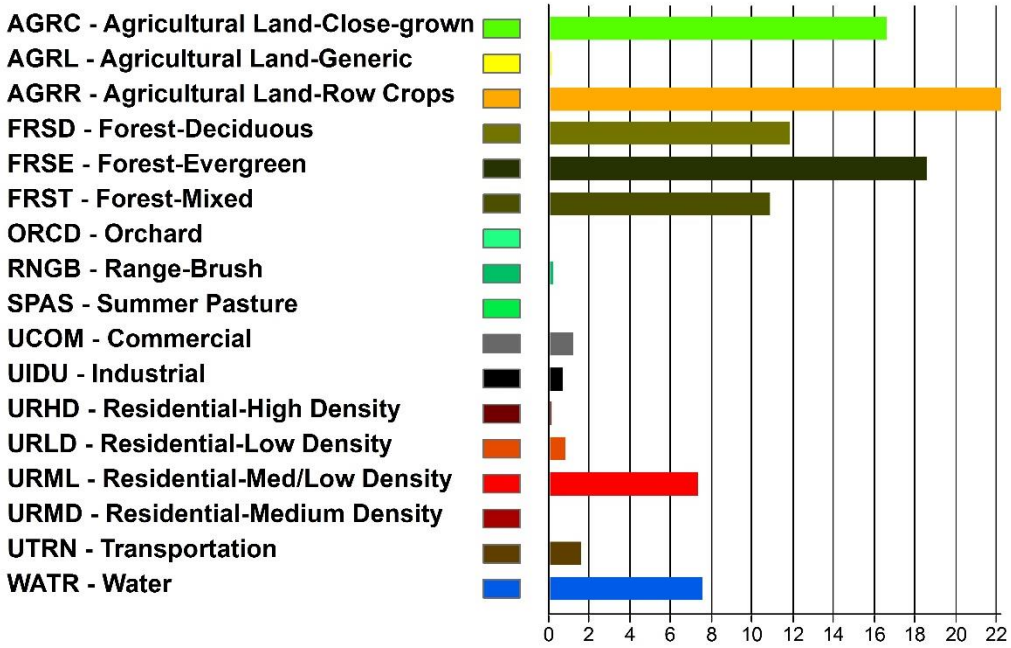


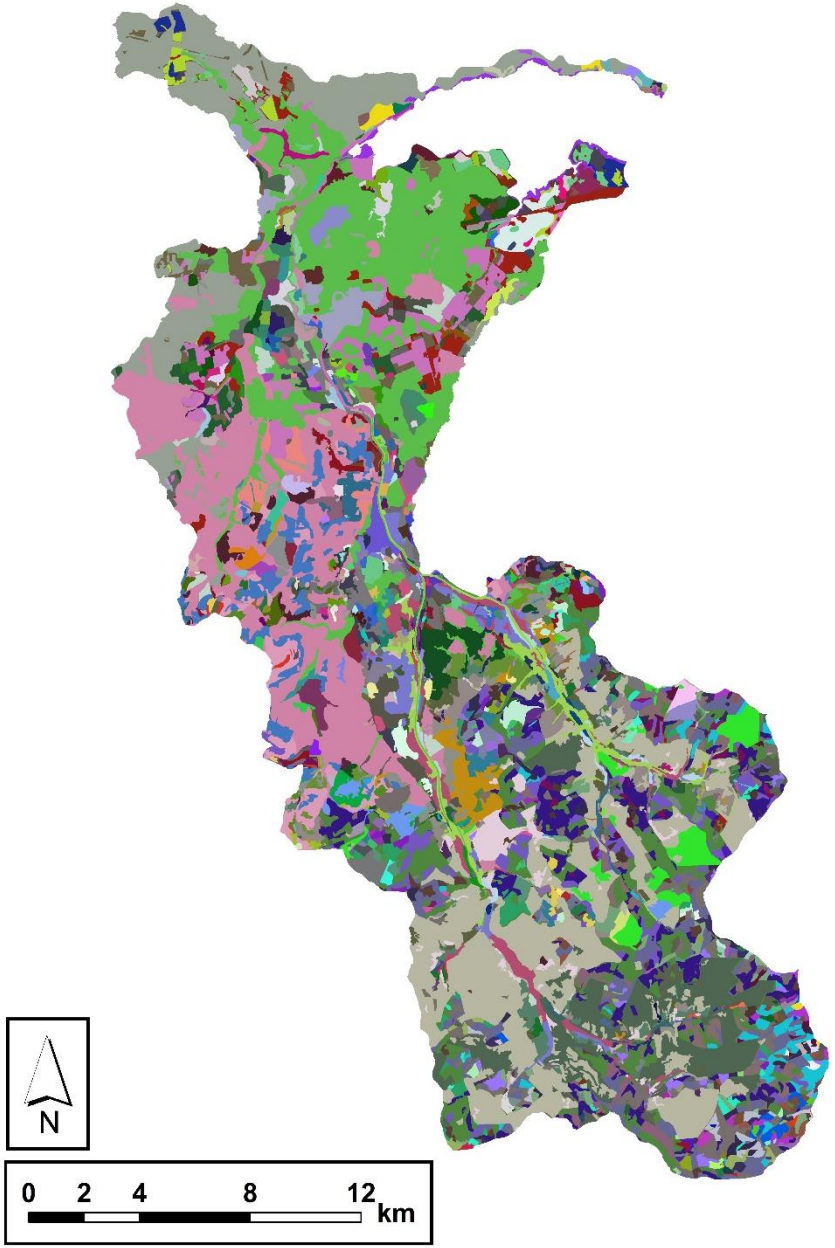
SWAT inputs – Land use





- Source: Regional geodetic survey
- 45 land use categories in the source data
- 17 aggregated SWAT categories

SWAT inputs - Soils



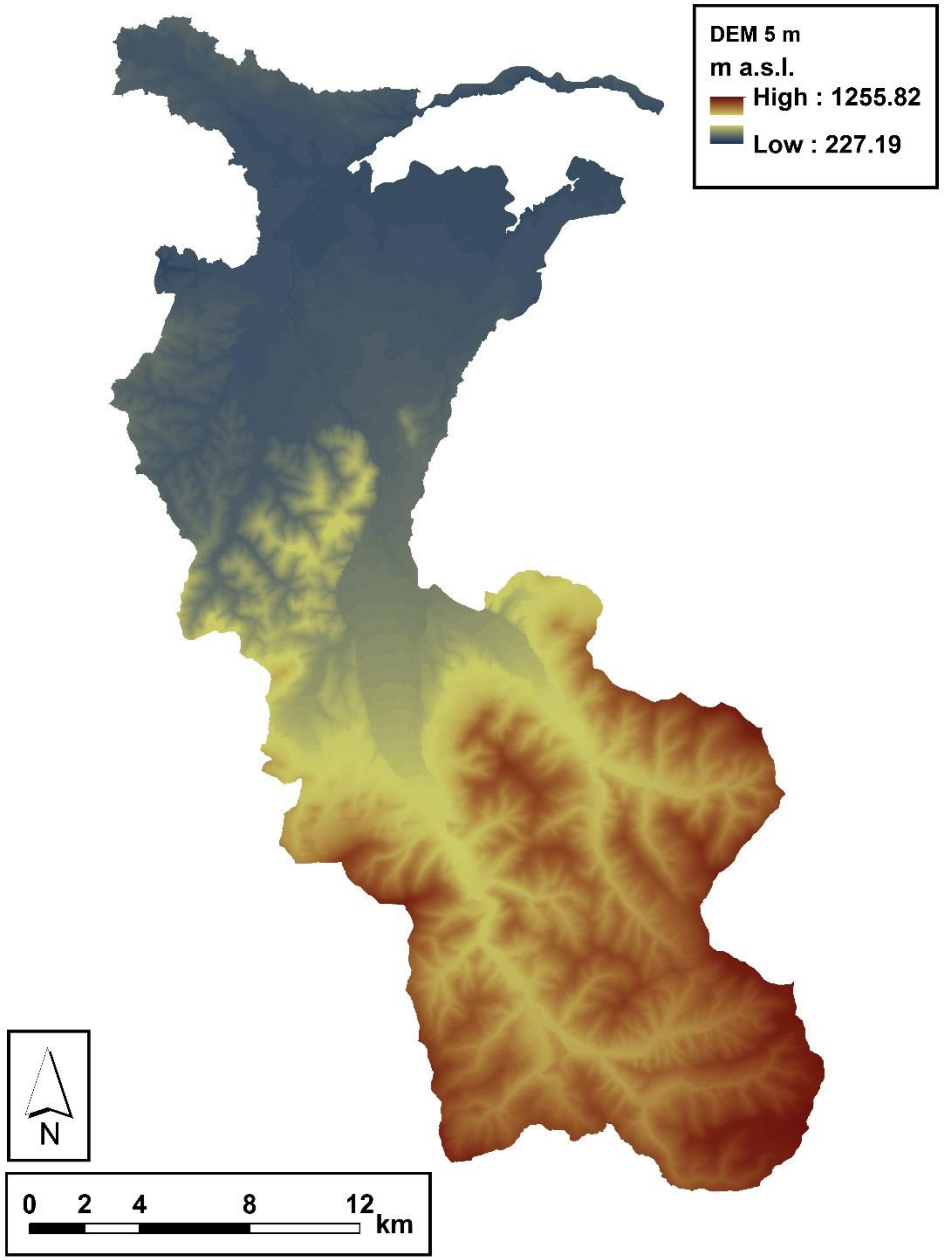
Sources:

- **Forests soils database**
- **Agricultural soil monitoring points**
- **Geological maps**

Soil types based on the texture at 10 depth intervals (bottoms: 10, 25, 40, 50, 80, 100, 130, 150, 160, 200 cm).

565 soil types identified and put into the SWAT database.

SWAT inputs – Elevation & Subbasins



Source: Regional geodetic survey

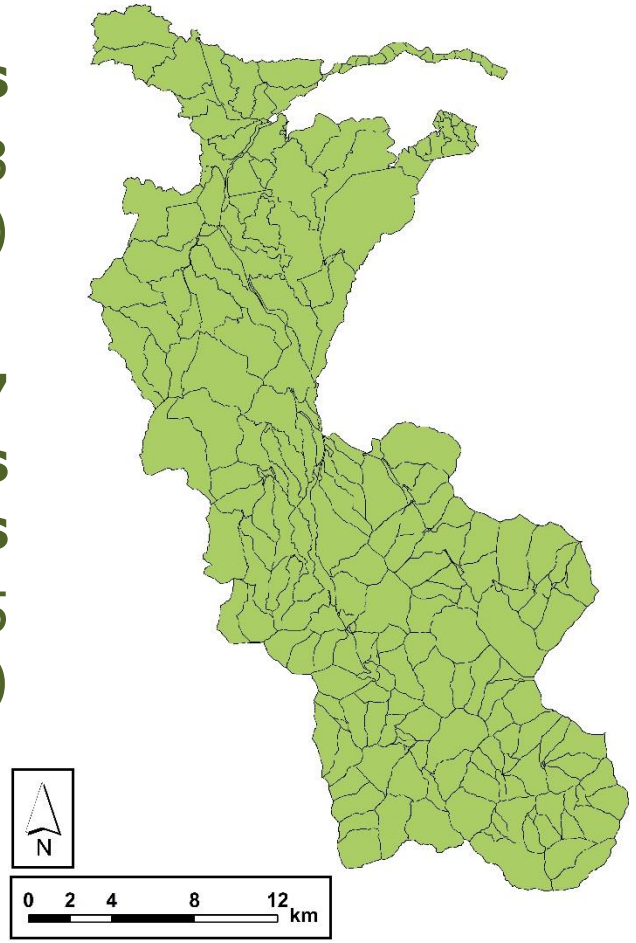
TIN data converted to the digital elevation model: 5x5 m

246 subbasins

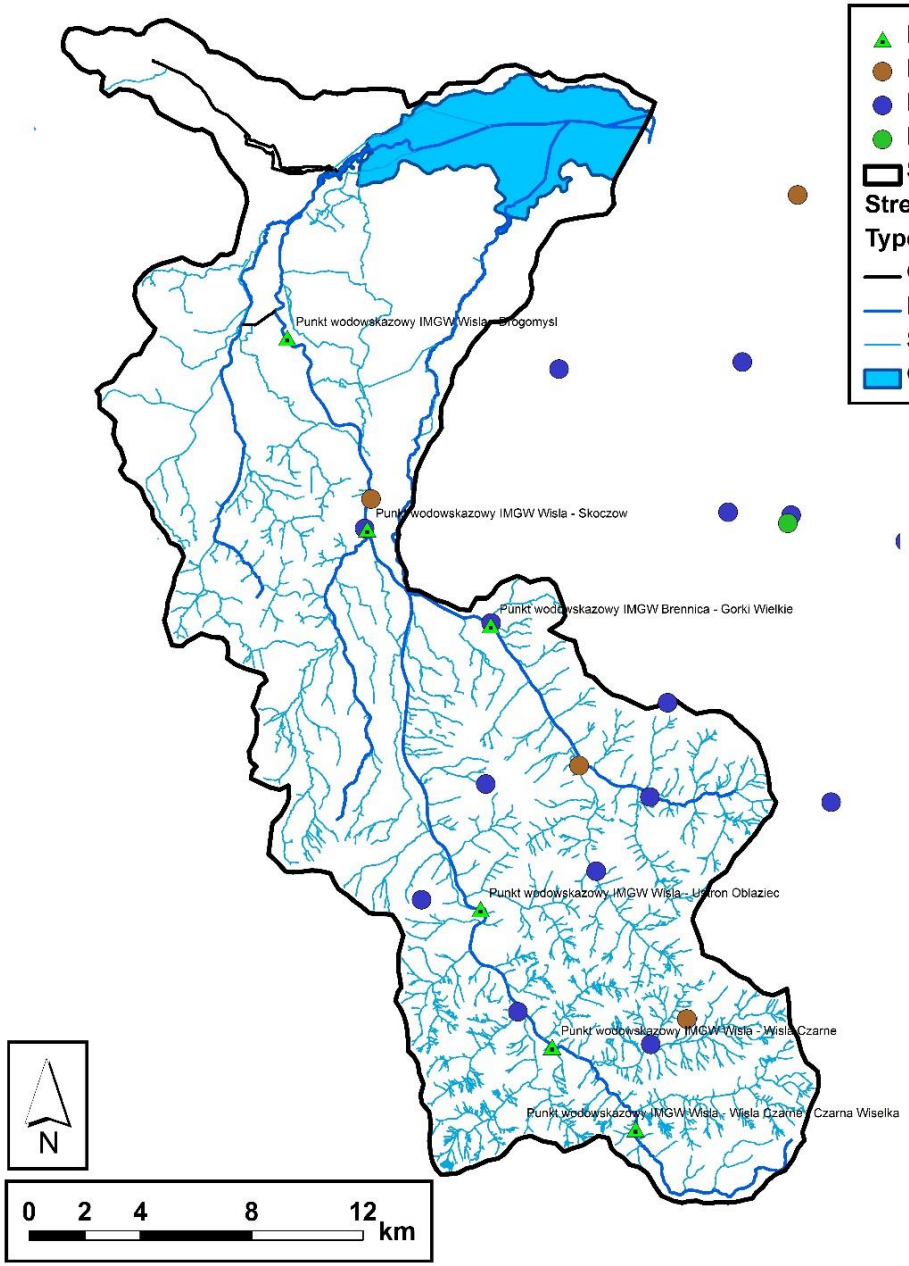
(average 253 ha/SUB)

29 807 Homogeneous Response Units

(average 1,85 ha/HRU)



SWAT inputs - Monitoring



6 flow gauges
Hourly real-time data
Daily archival data

11 rain gauges
Hourly real-time data
Daily archival data

4 meteorological stations
Real-time hourly data (except solar radiation)

1 meteorological station
Long term daily monitoring data

8 water quality monitoring points (regional state monitoring system)
Monthly measurements (full scope)

8 water quality monitoring points (CRIS)
Monthly measurements (nutrients, silica)

1 real time water quality monitoring point
temperature and turbidity

1 sediments granulometry monitoring point
Inflow to the reservoir; monthly measurements

SWAT – Run (daily)

Step 1: Meteorological input files are updated with the latest 24 hours of observations and 24 hours of forecasts

Step 2: All models run is extended to cover present day + 24 hours of forecast:
(Model run is from 1/1/2011 with 3 years of warm-up period)

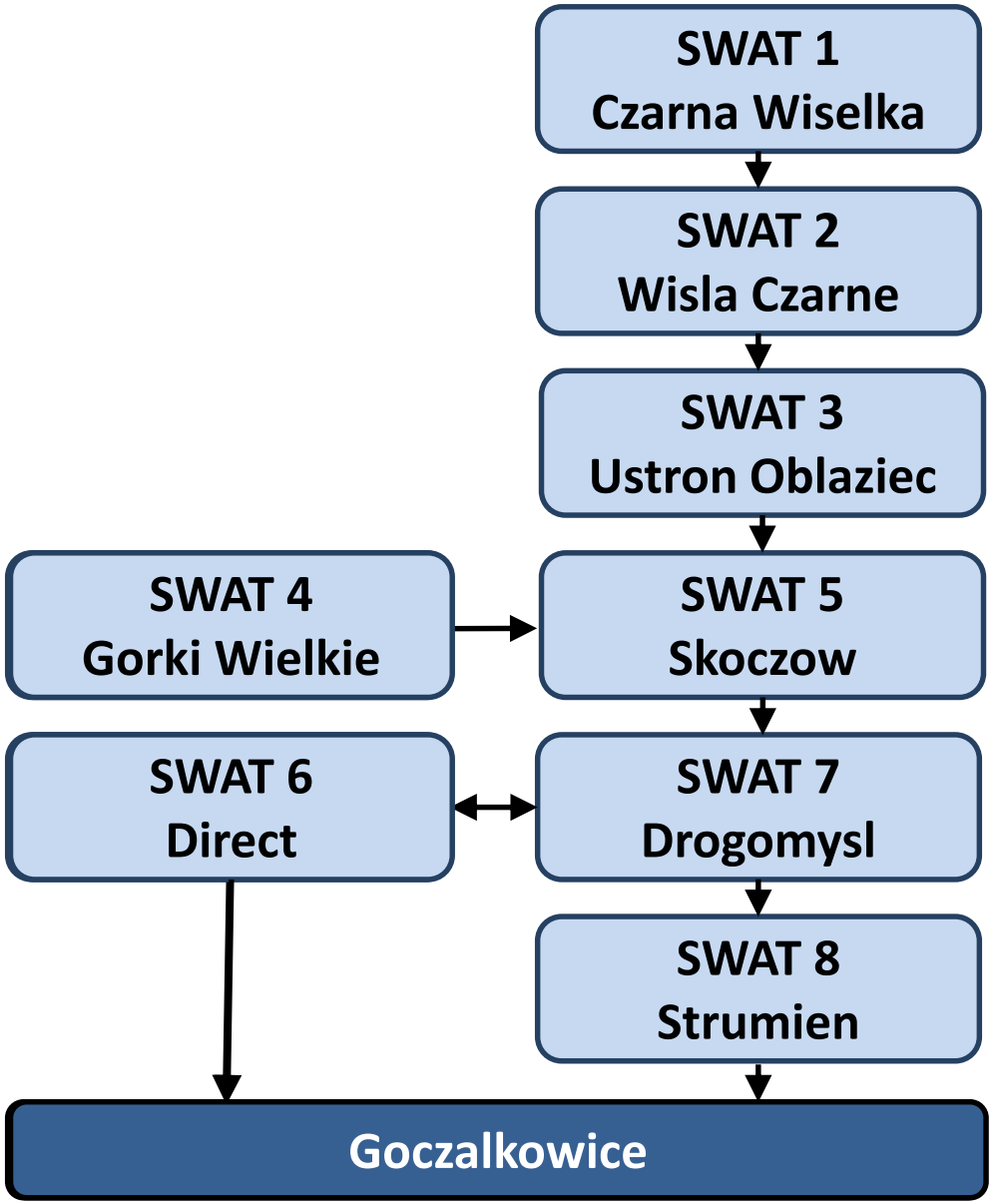
Step 3: Models 1, 4, and 6 are run (models with no inlet)

Step 4: Export of outputs from Models 1, 4, and 6 to the SQL database

Step 5: Inlet points input files are updated with the latest 24 hours of observations and next 24 hours of forecasts calculated by the upstream SWAT models

Step 6: Next downstream SWAT model is run

Step 7: Export of outputs from next downstream SWAT model to the SQL database



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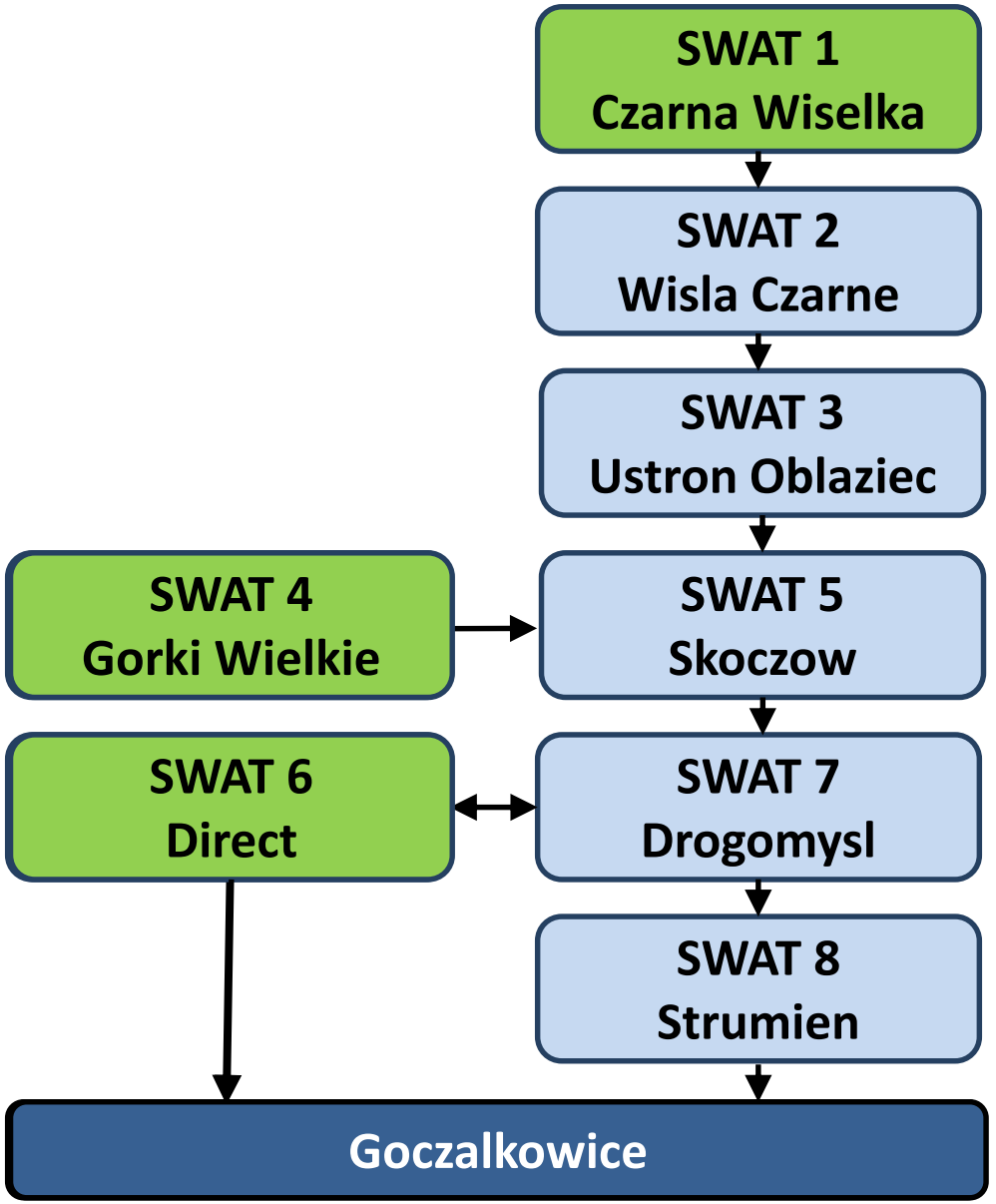

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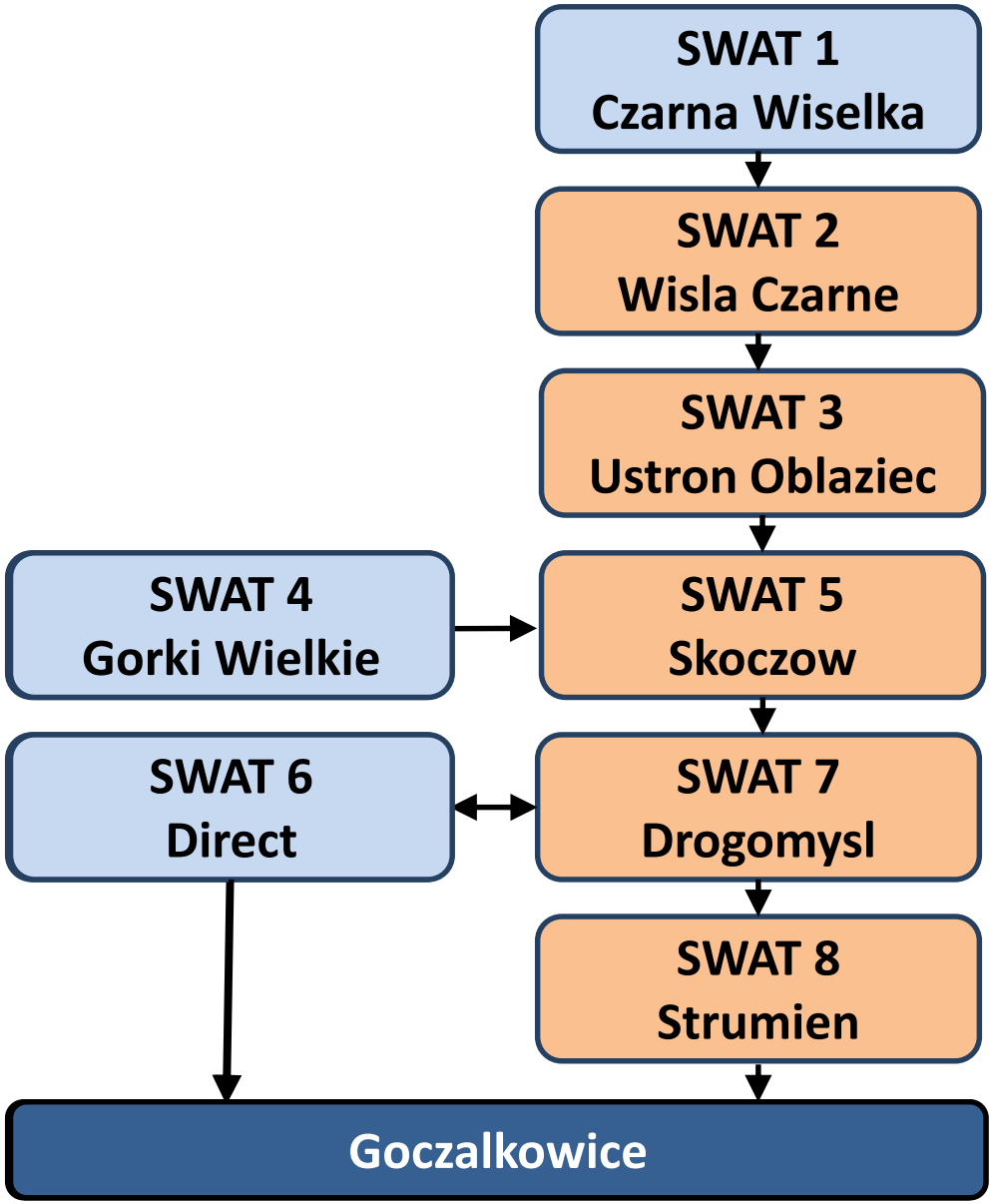


SWAT – Calibration (monthly)

Step 1: Copying all SWAT models to the Calibration directories

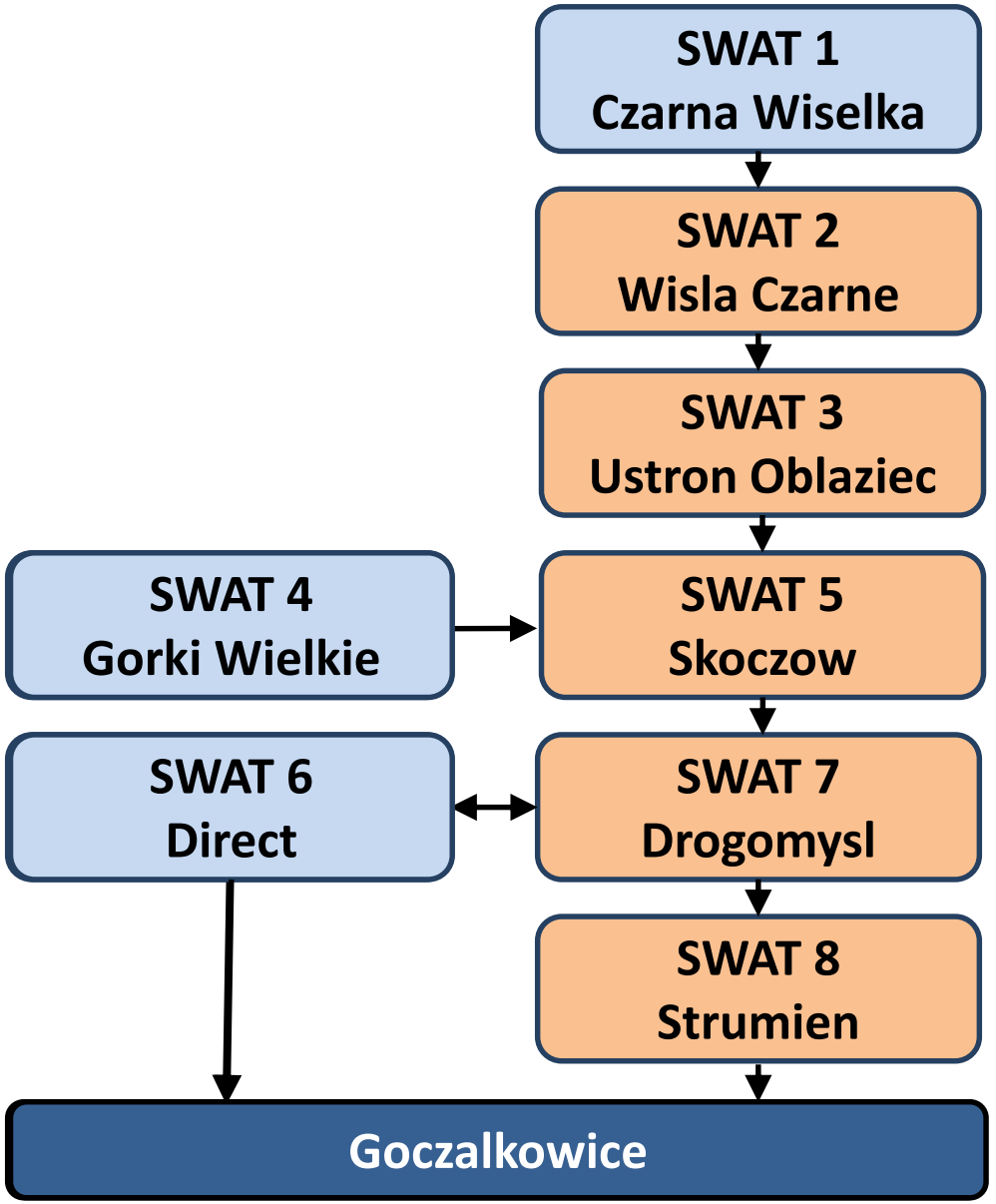
Step 2: Extending observed flow data and water quality data in the SWAT-CUP ParaSol observation files

Step 3: Running the calibration of models with no inlets (models 1, 4 and 6

Step 4: Rewriting of inlet point data files based on models that were calibrated

Step 5: Calibration of next downstream model

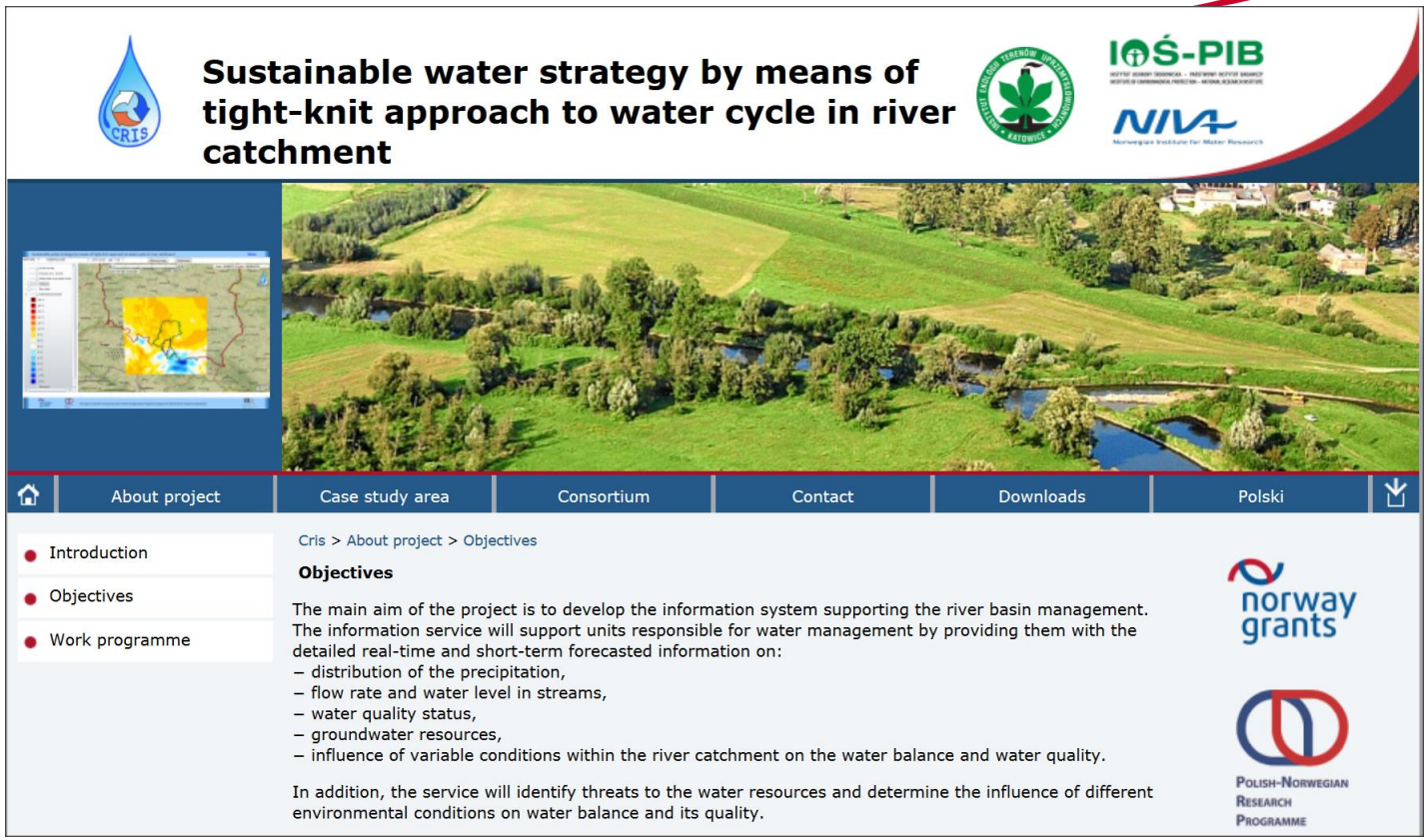
Step 6: Copying of calibrated mdels to the daily runs directories



SWAT – Outputs for WWW

List of parameters to be presented online

- Actual evapotranspiration
- Percolation past root zone
- Surface runoff
- Organic N transported from subbasin to reach
- Organic P transported from subbasin to reach
- N-NO3 in surface runoff
- Soluble P in surface runoff
- Mineral P in surface runoff
- N-NO3 loads to the groundwater
- Streamflow
- Sediment loads transported from reach
- Sediment concentration in reach
- Organic N in the outflow
- Organic P in the outflow
- N-NO3 in the outflow
- N-NH4 in the outflow
- N-NO2 in the outflow
- Mineral P in the outflow
- Total N in surface runoff
- Total P in surface runoff
- Sand in the outflow
- Silt in the outflow
- Clay in the outflow
- Total suspended solids



SWAT – Outputs for WWW

Sustainable water strategy by means of tight-knit approach to water cycle in river catchment

About project | Case study area | Consortium | Contact | Downloads | Polski

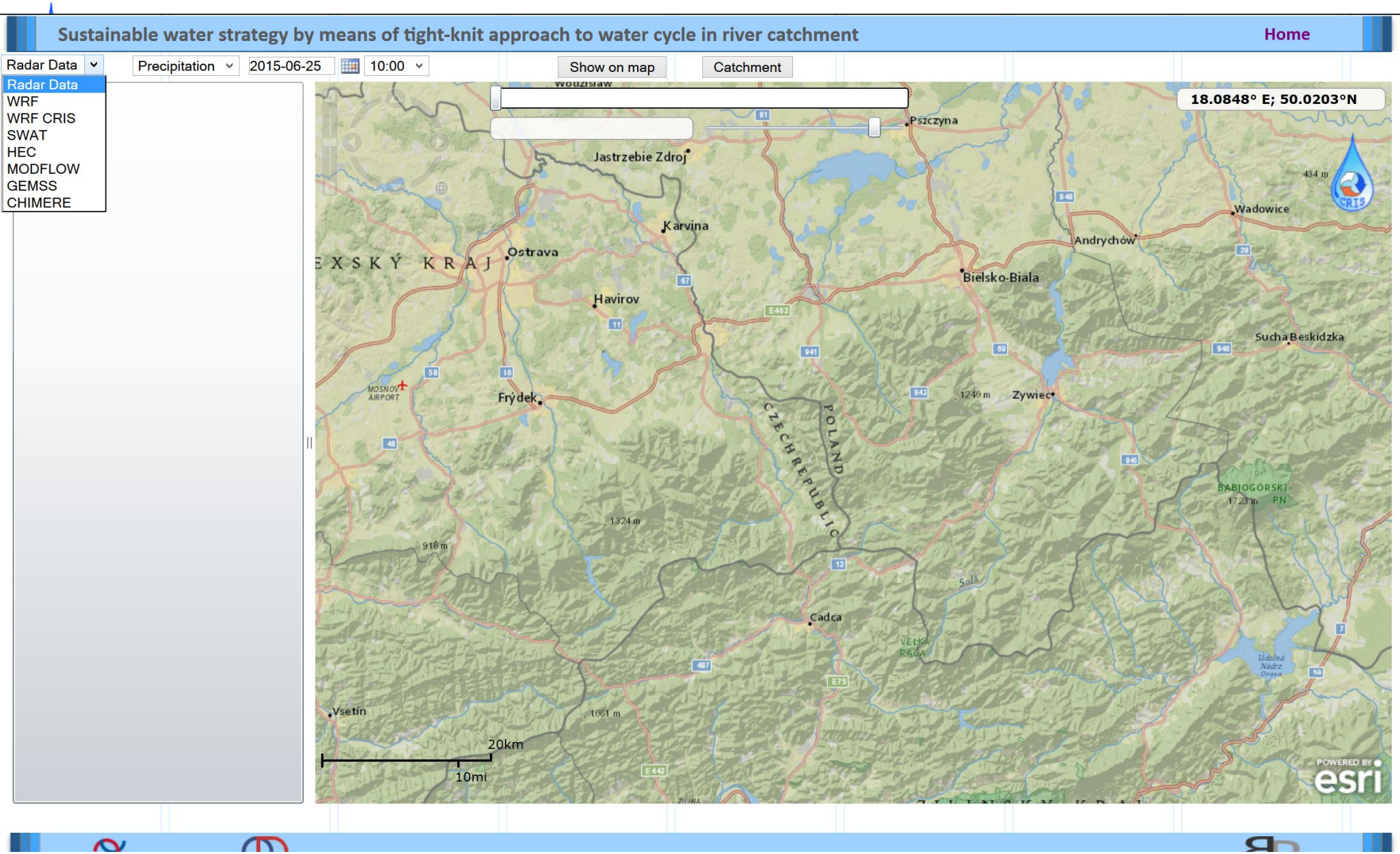
- Introduction
- Objectives
- Work programme

Cris > About project > Objectives

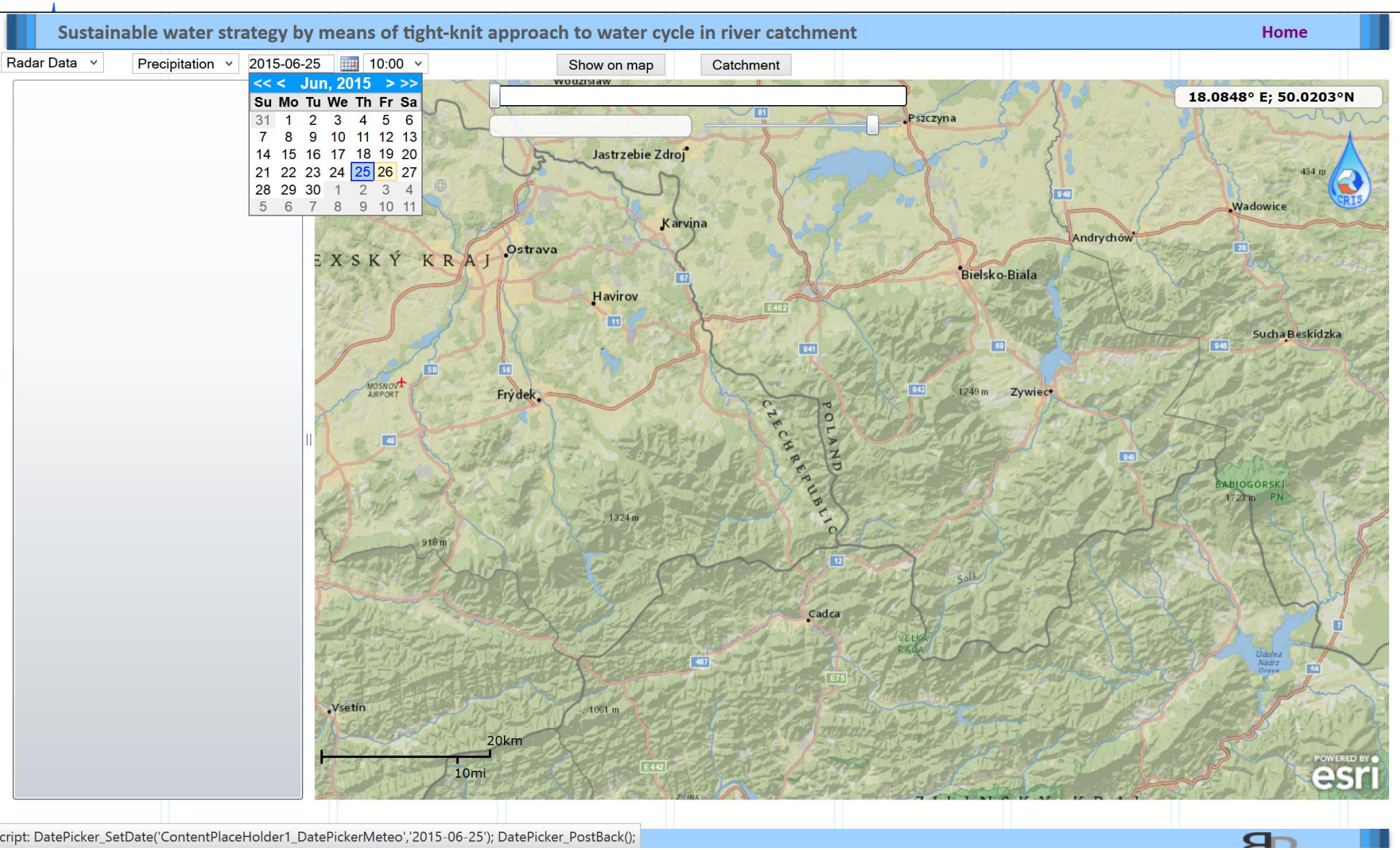
Objectives

The main aim of the project is to develop the information system supporting the river basin management. The information service will support units responsible for water management by providing them with the detailed real-time and short-term forecasted information on:
– distribution of the precipitation,
– flow rate and water level in streams,

www.cris.ietu.katowice.pl
(key words: CRIS IOS, CRIS IETU, CRIS NIVA)



CRIS information system



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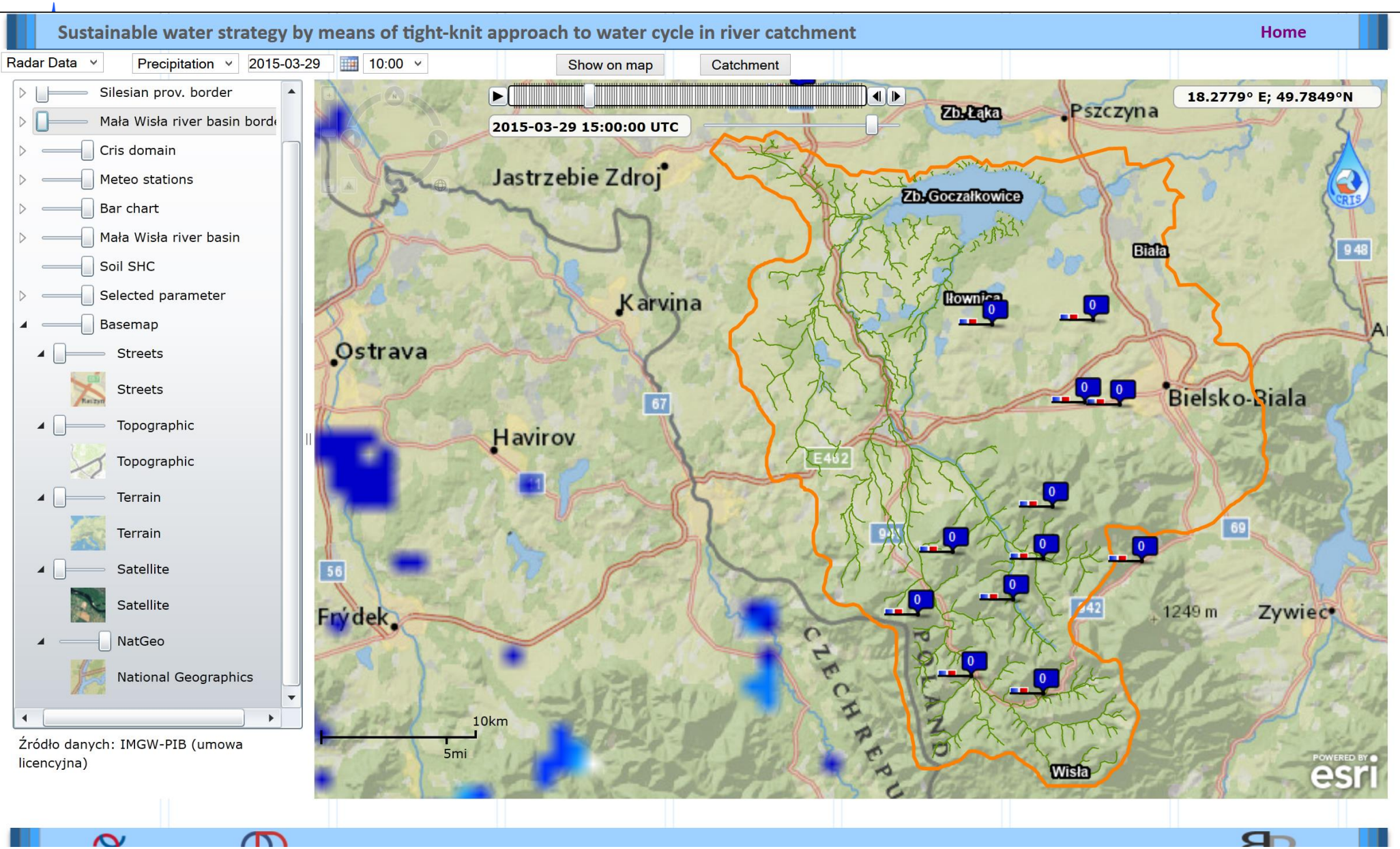
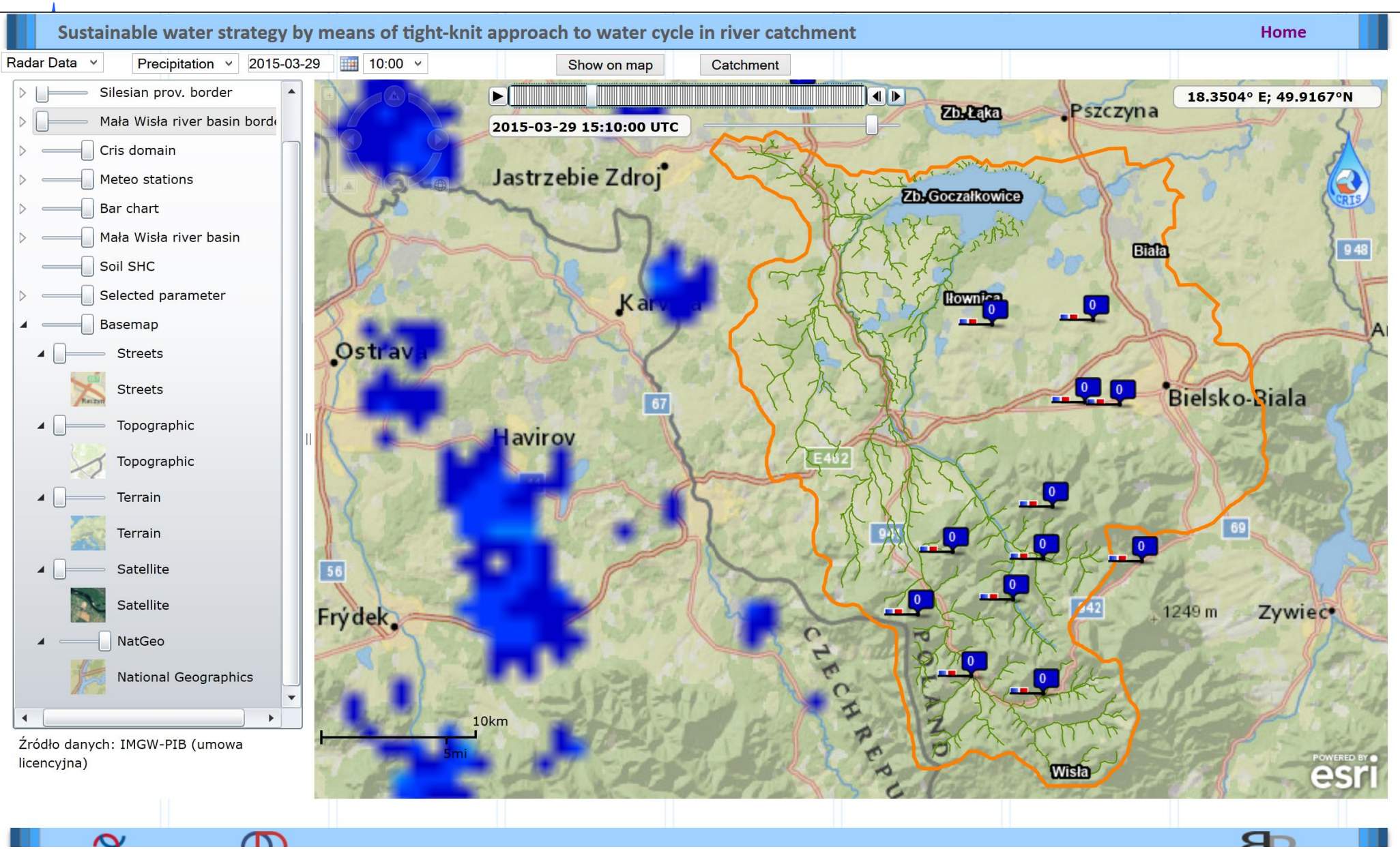


CRIS information system – radar data



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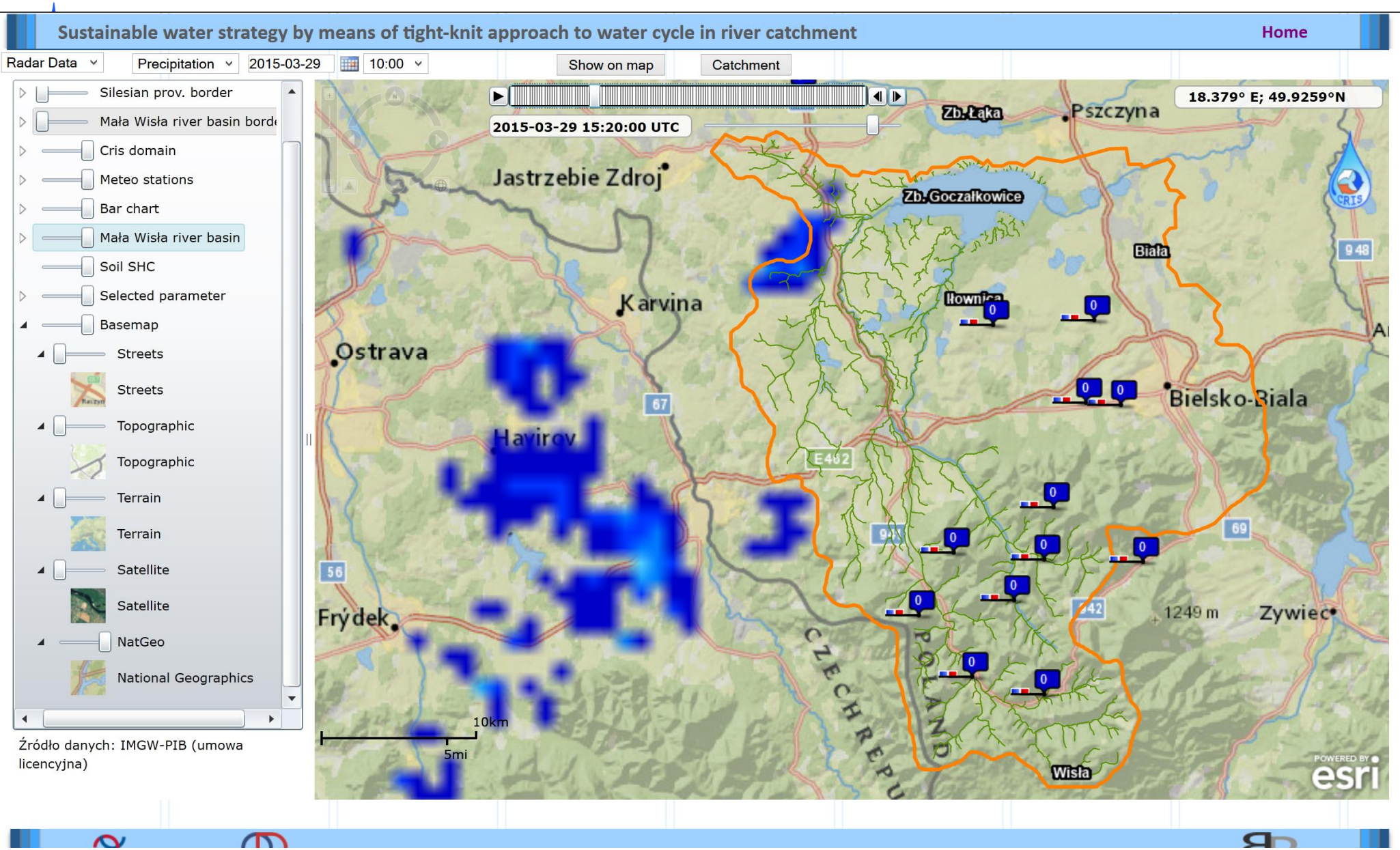

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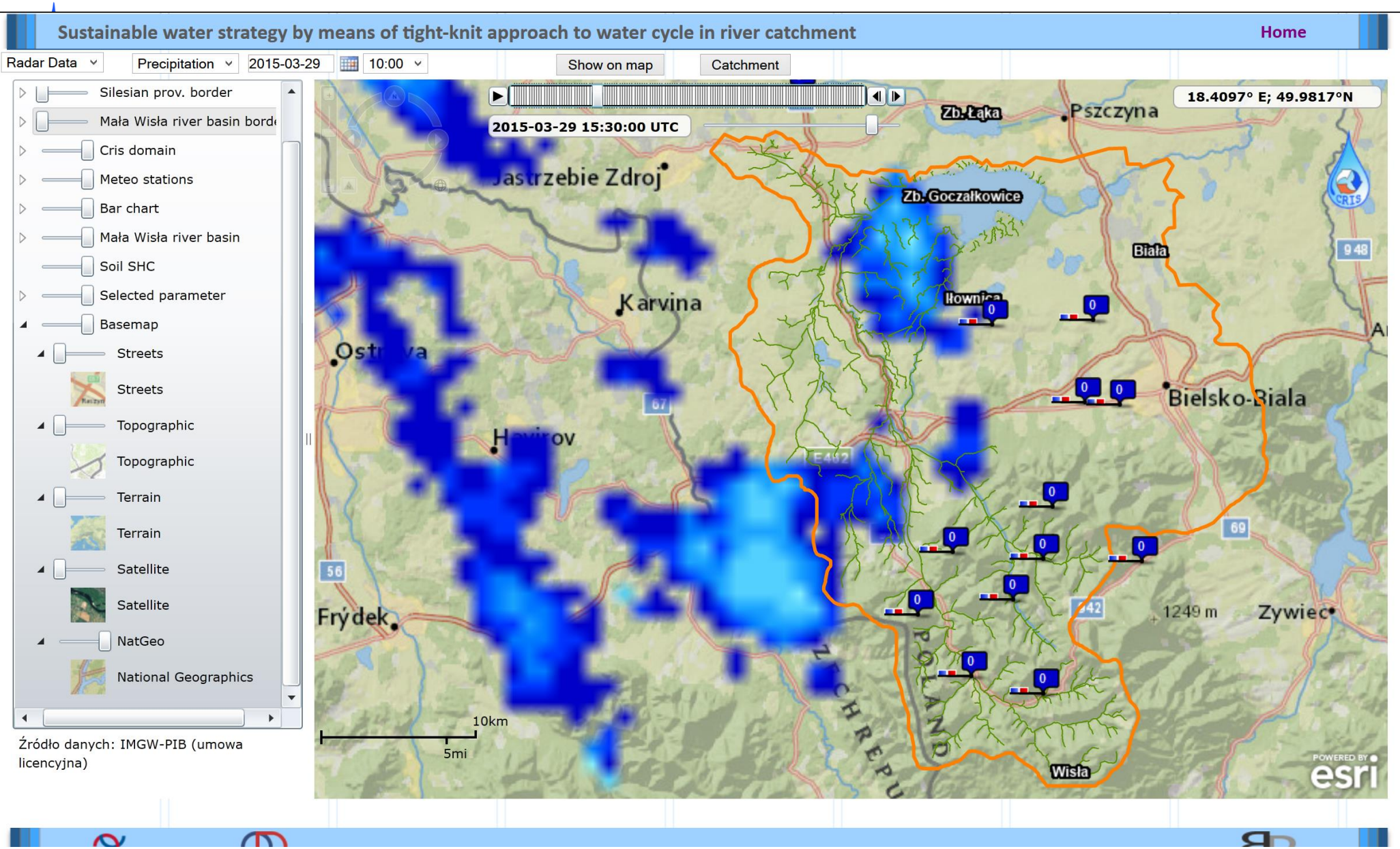

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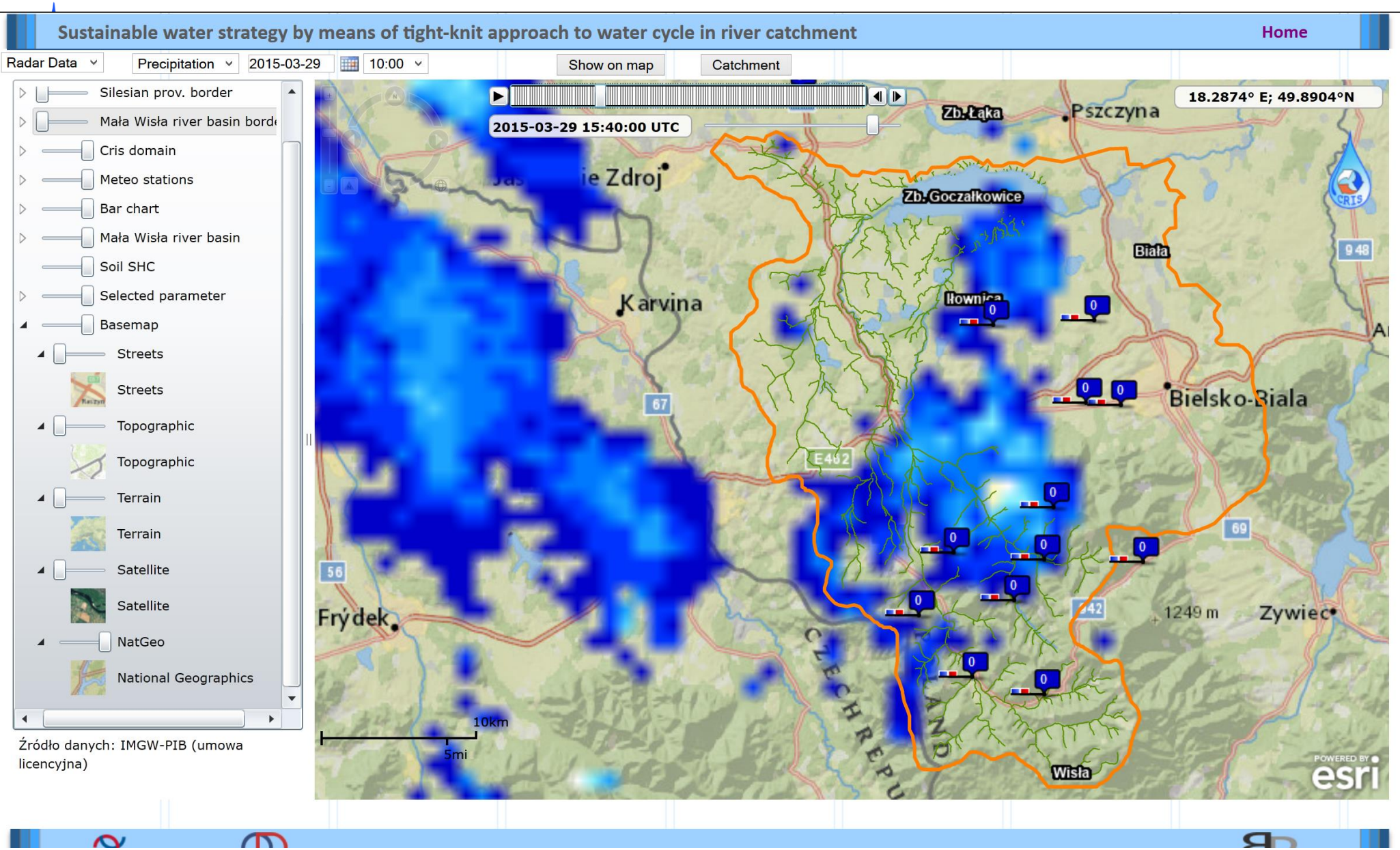

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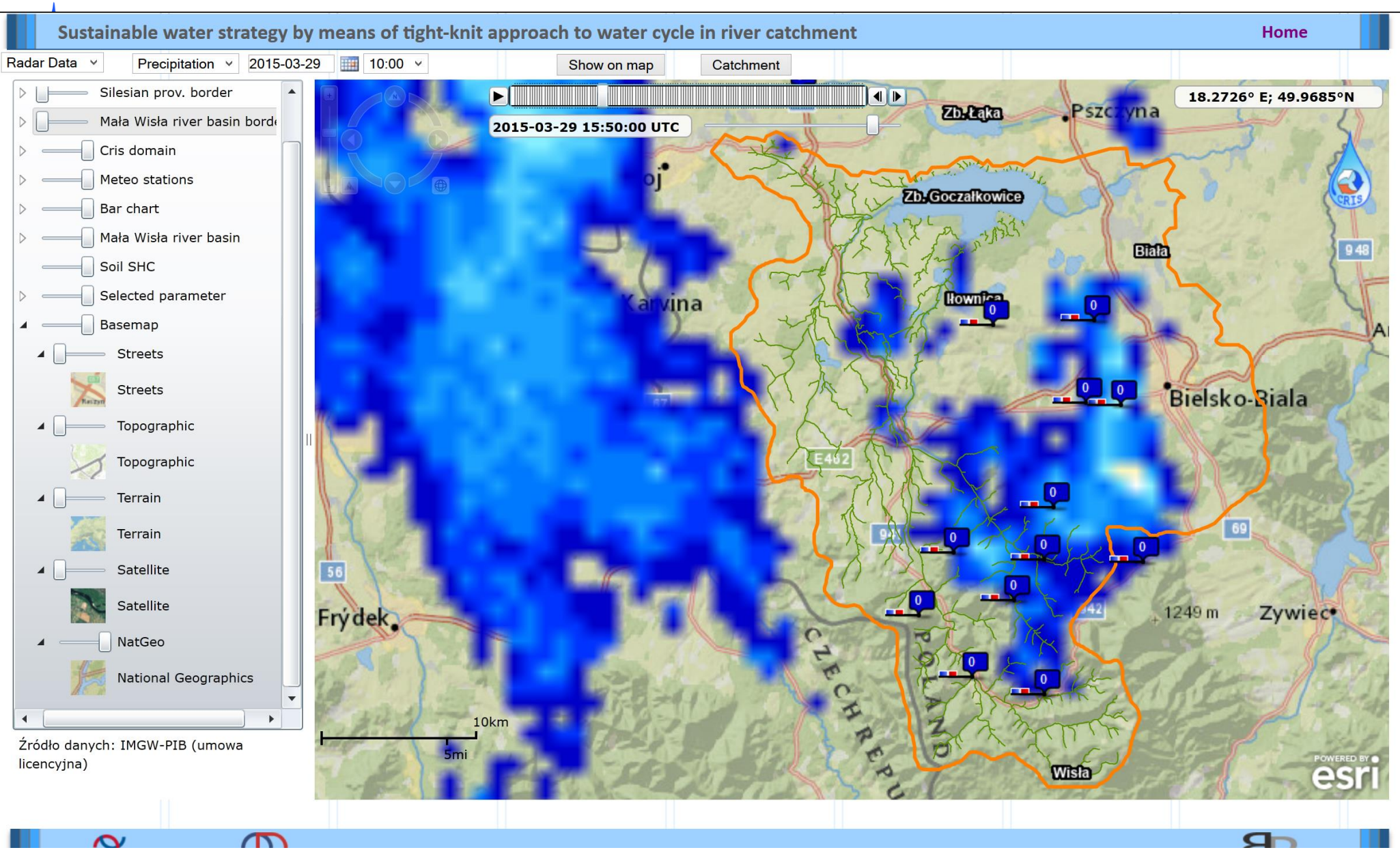

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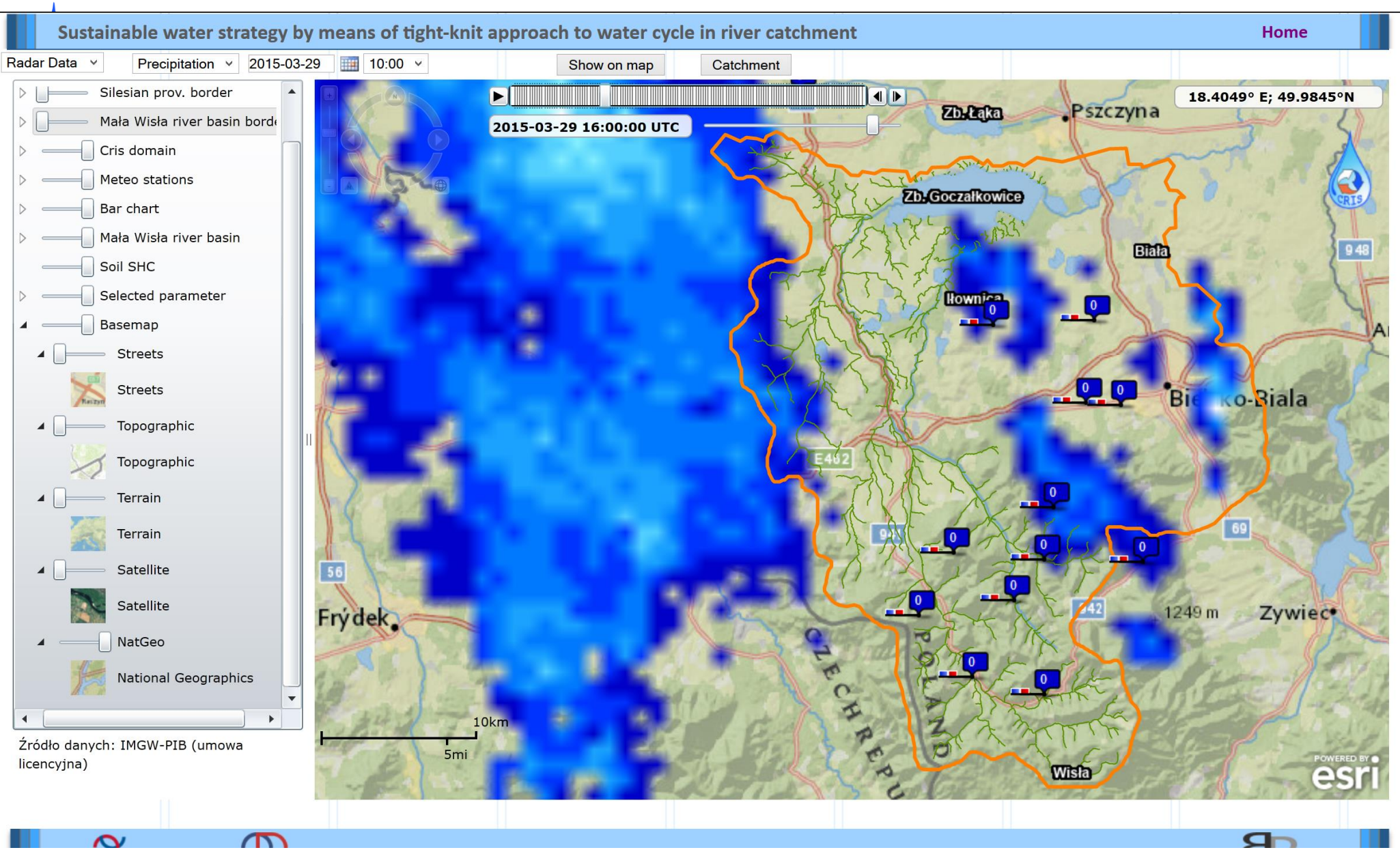

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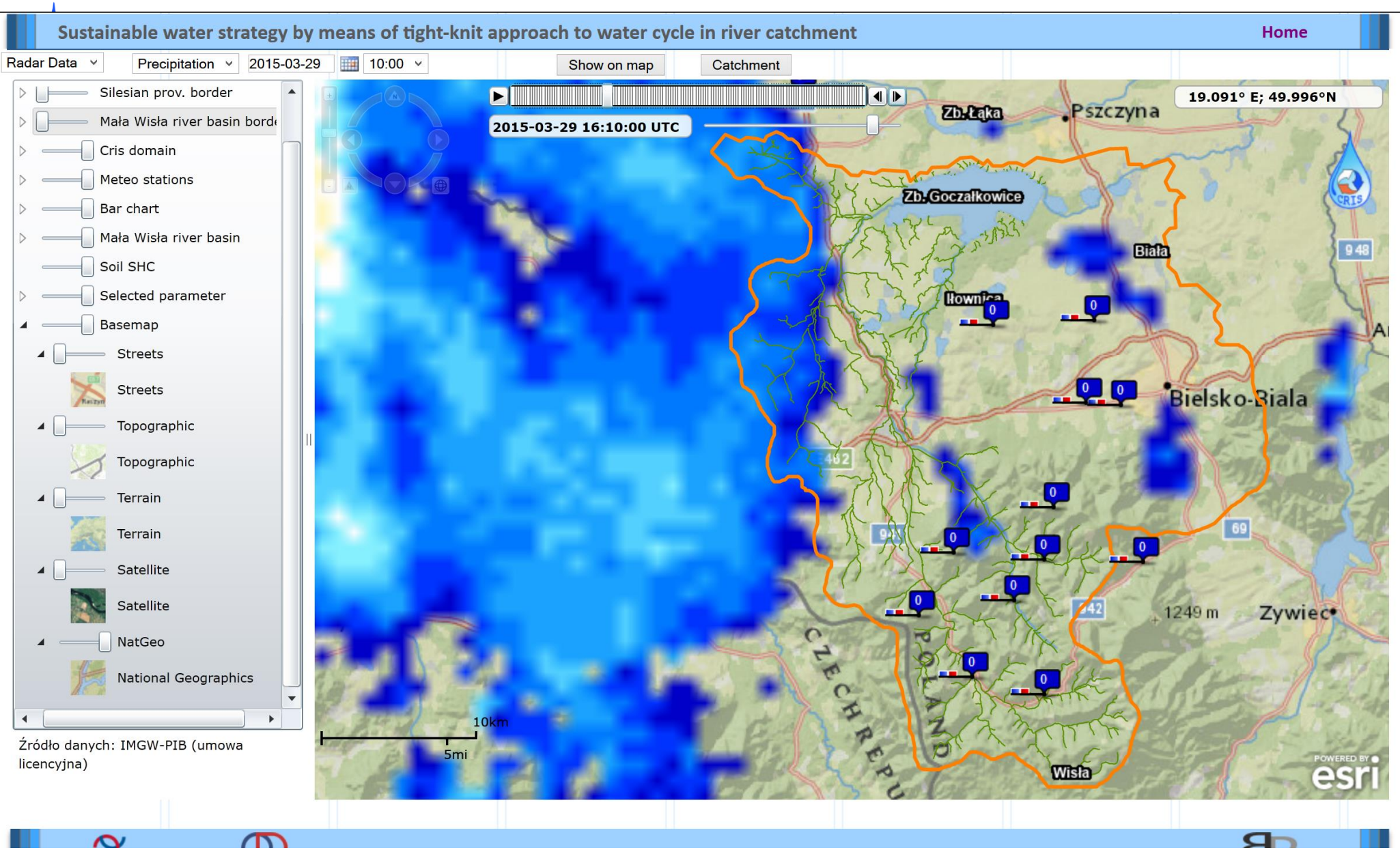

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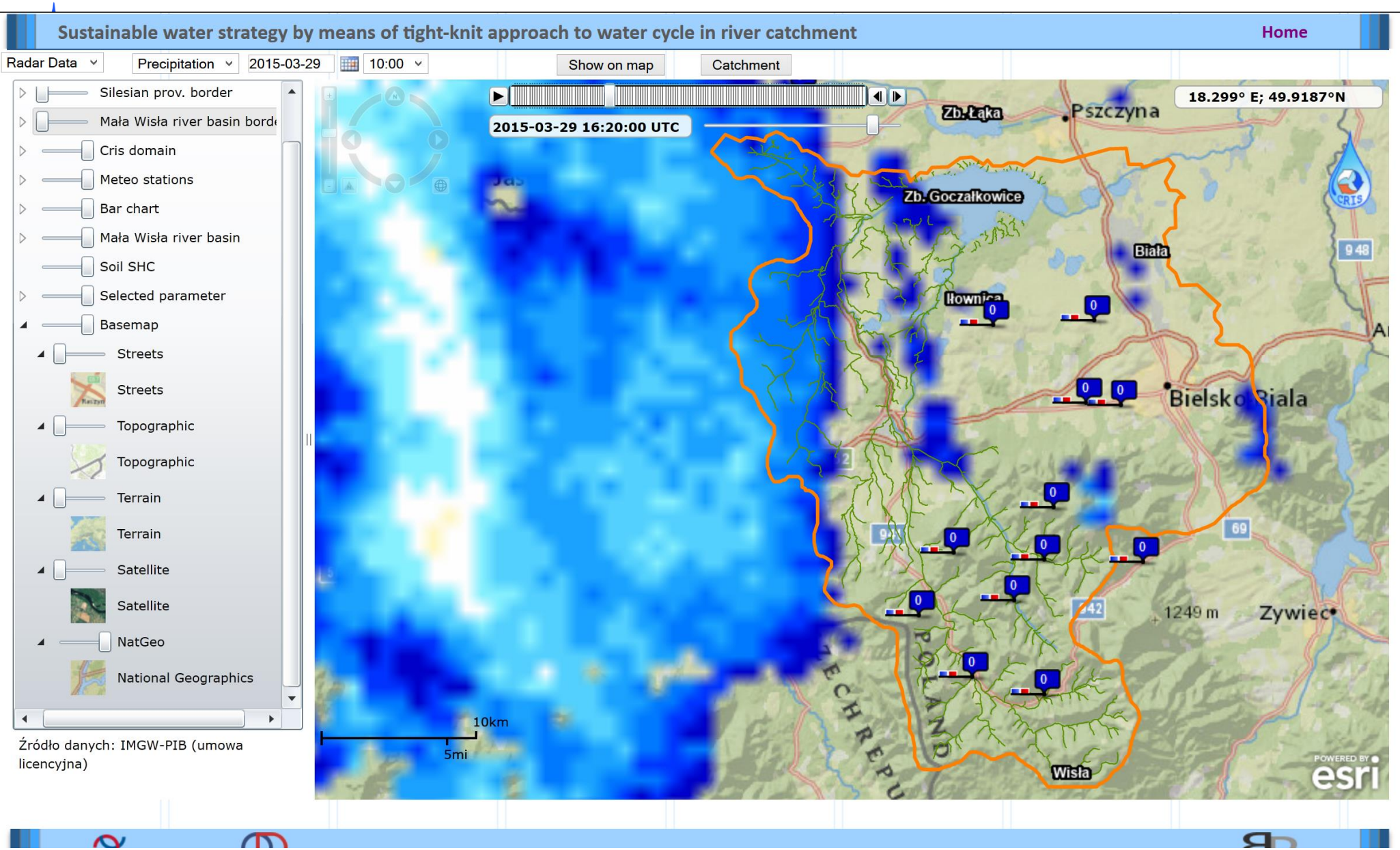

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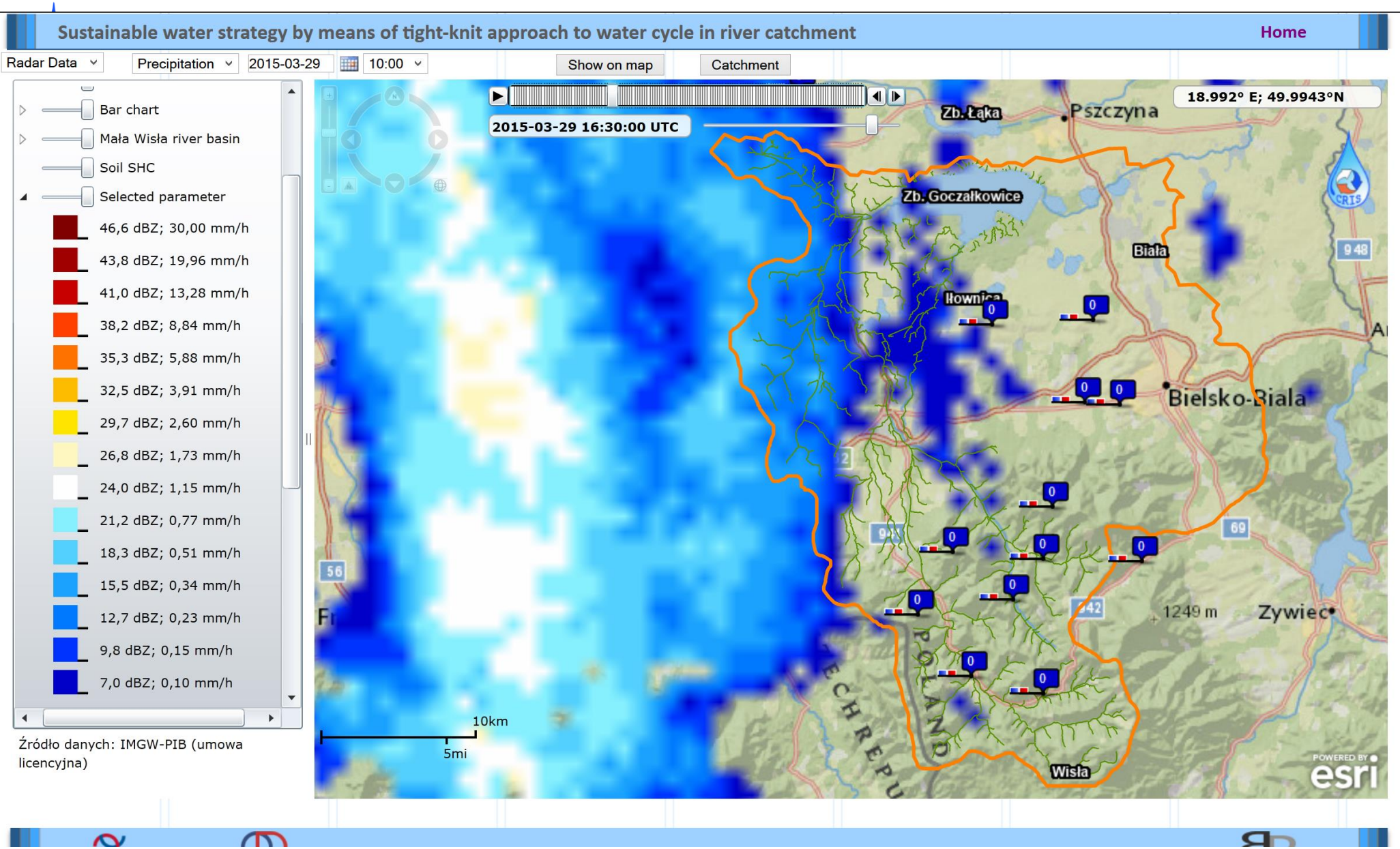

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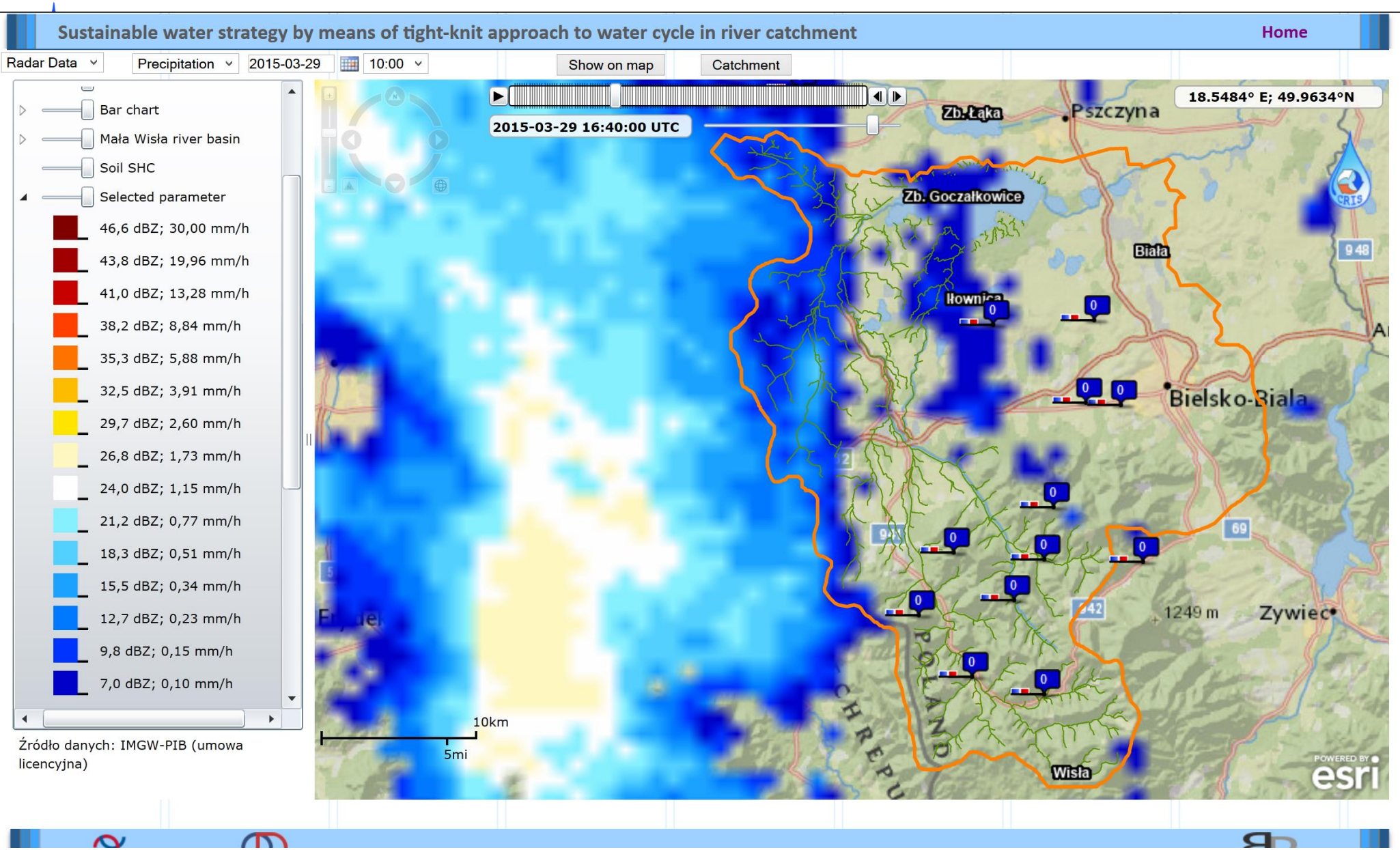

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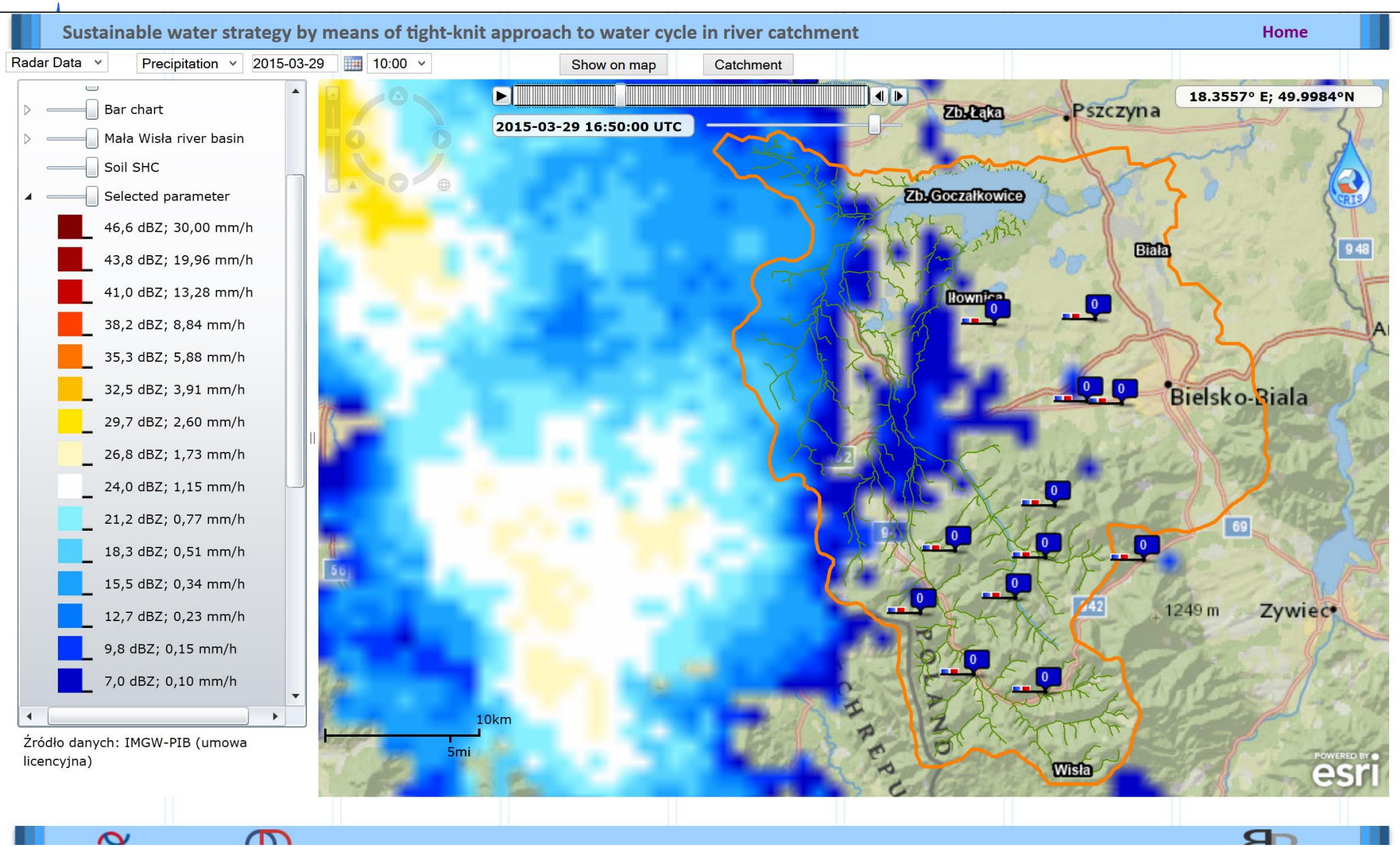

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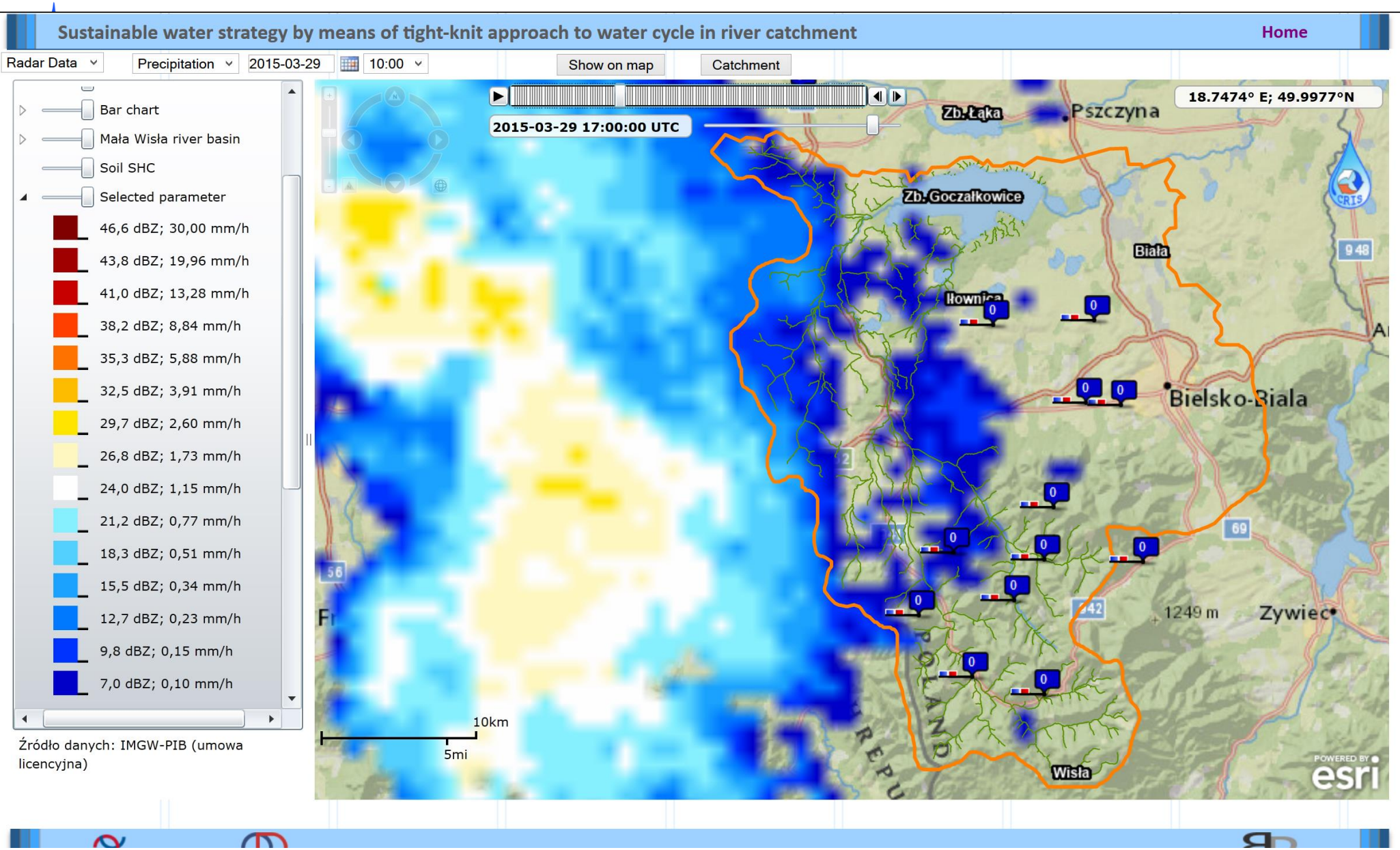

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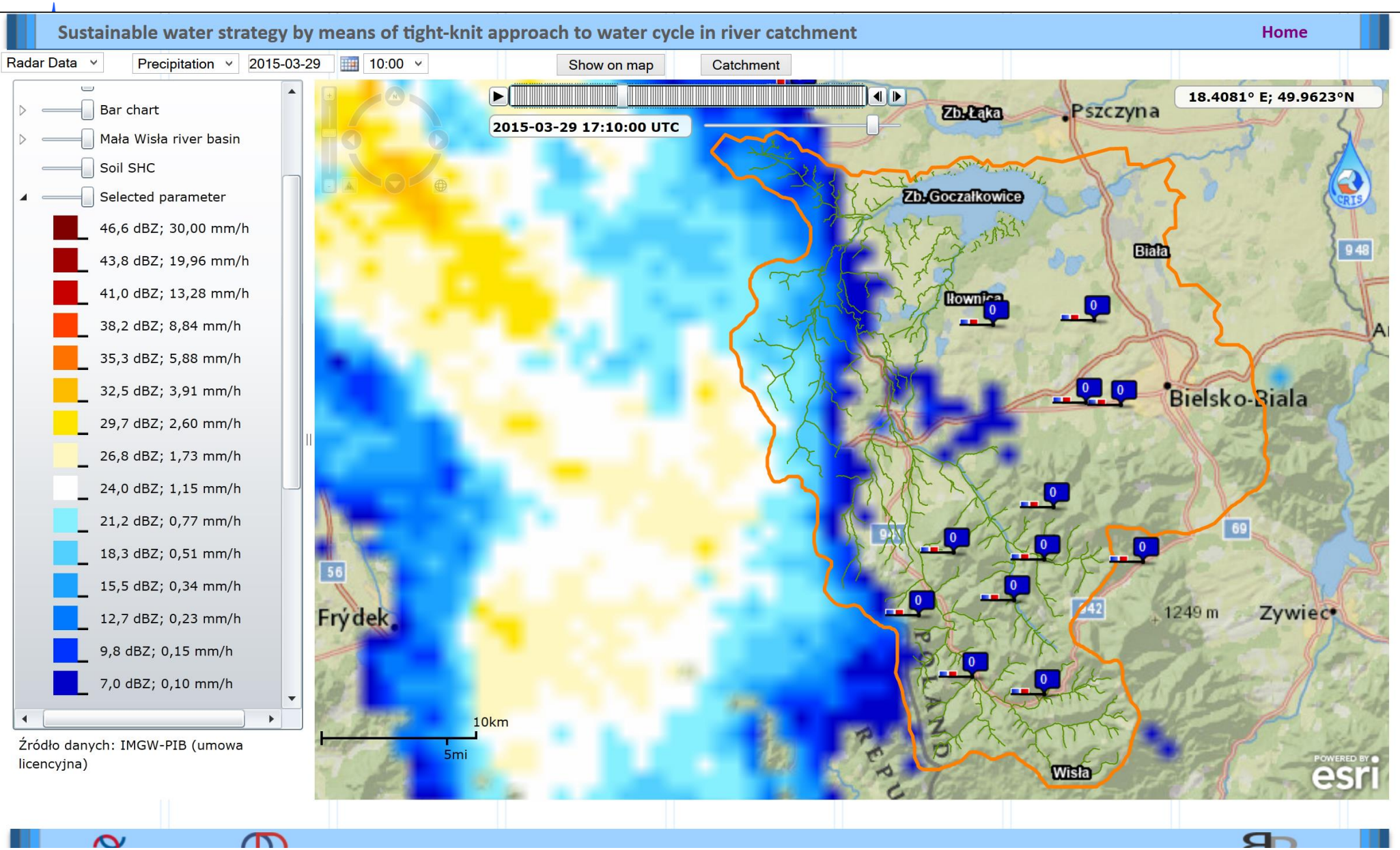

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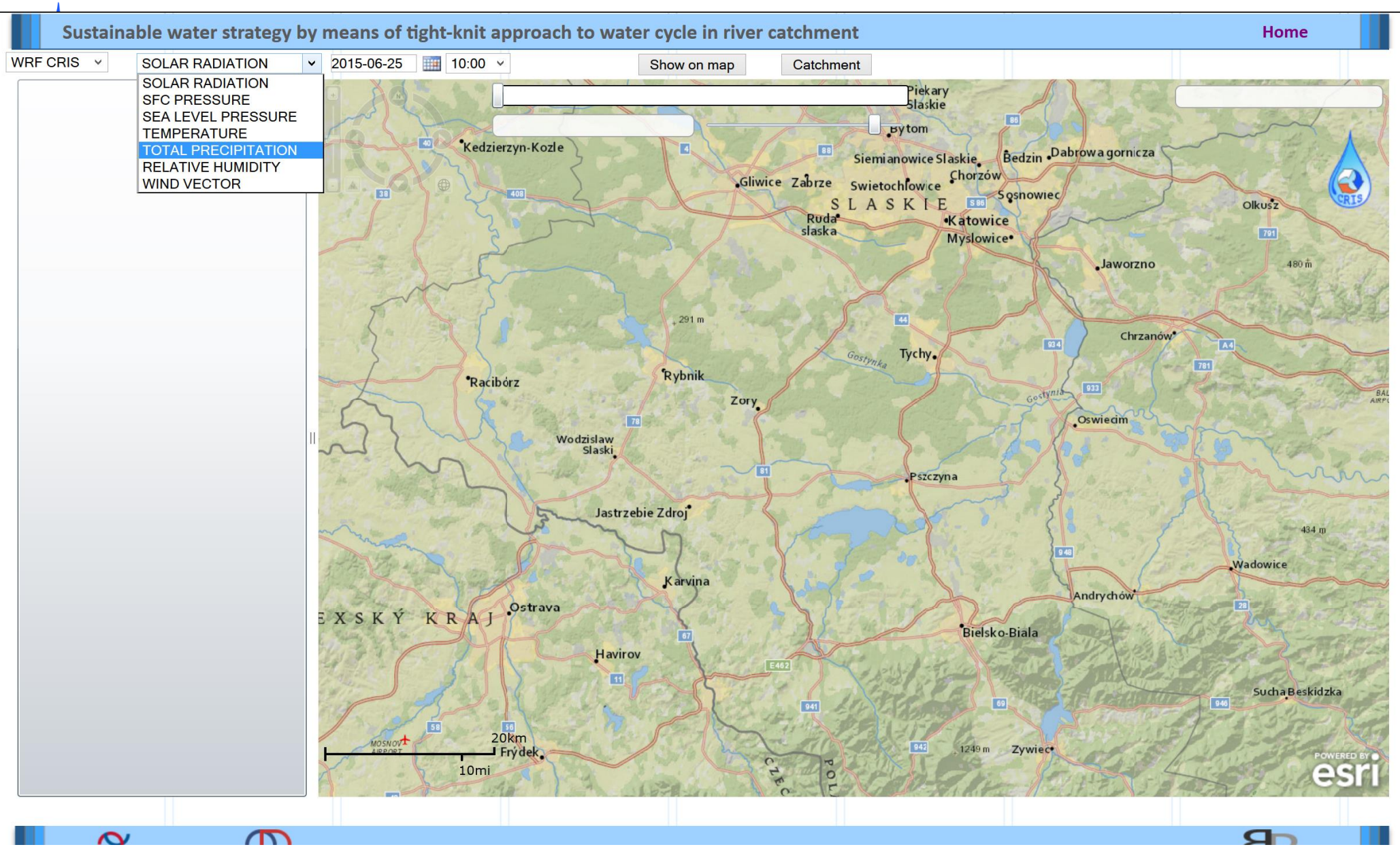
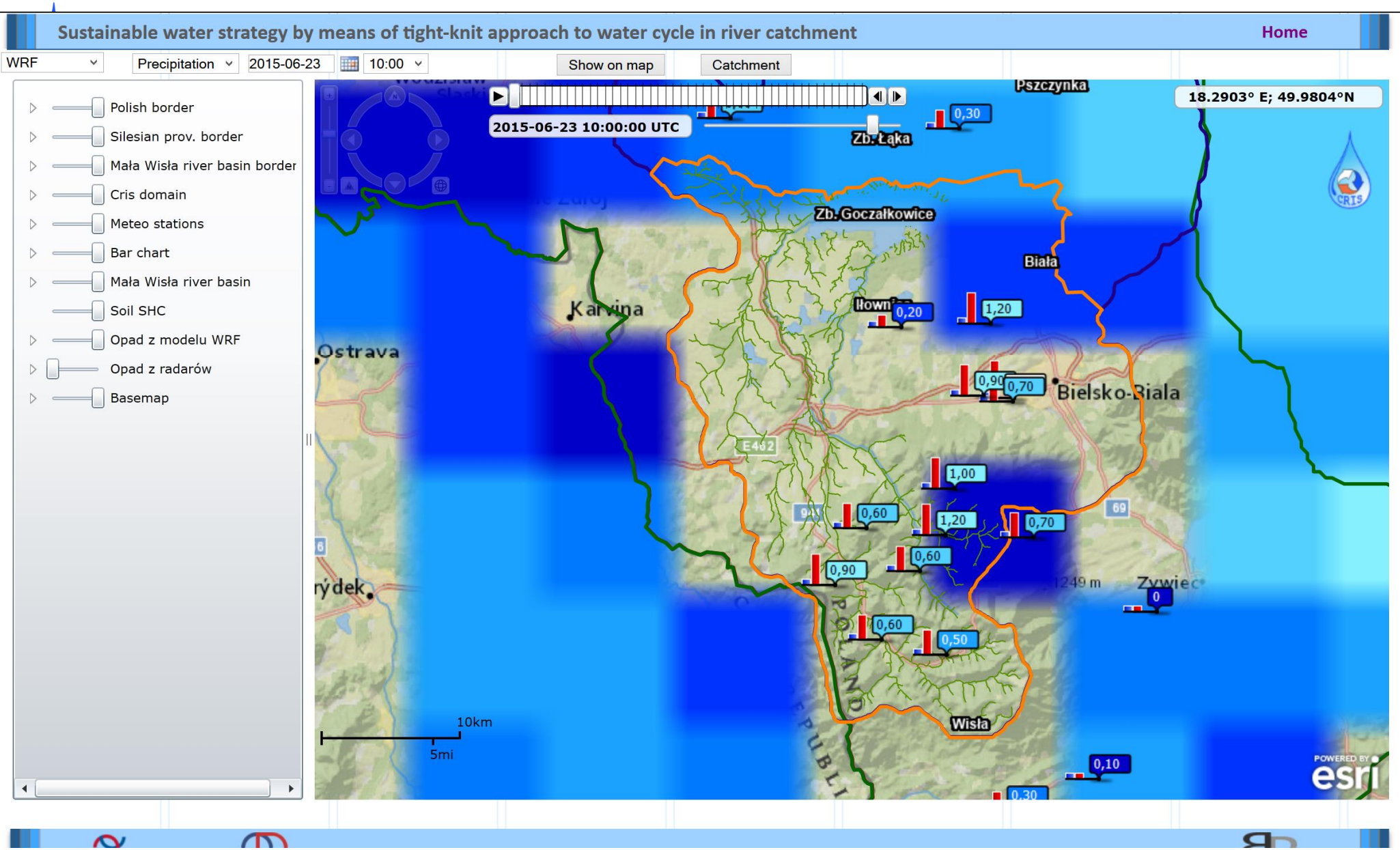


CRIS information system – WRF forecasts



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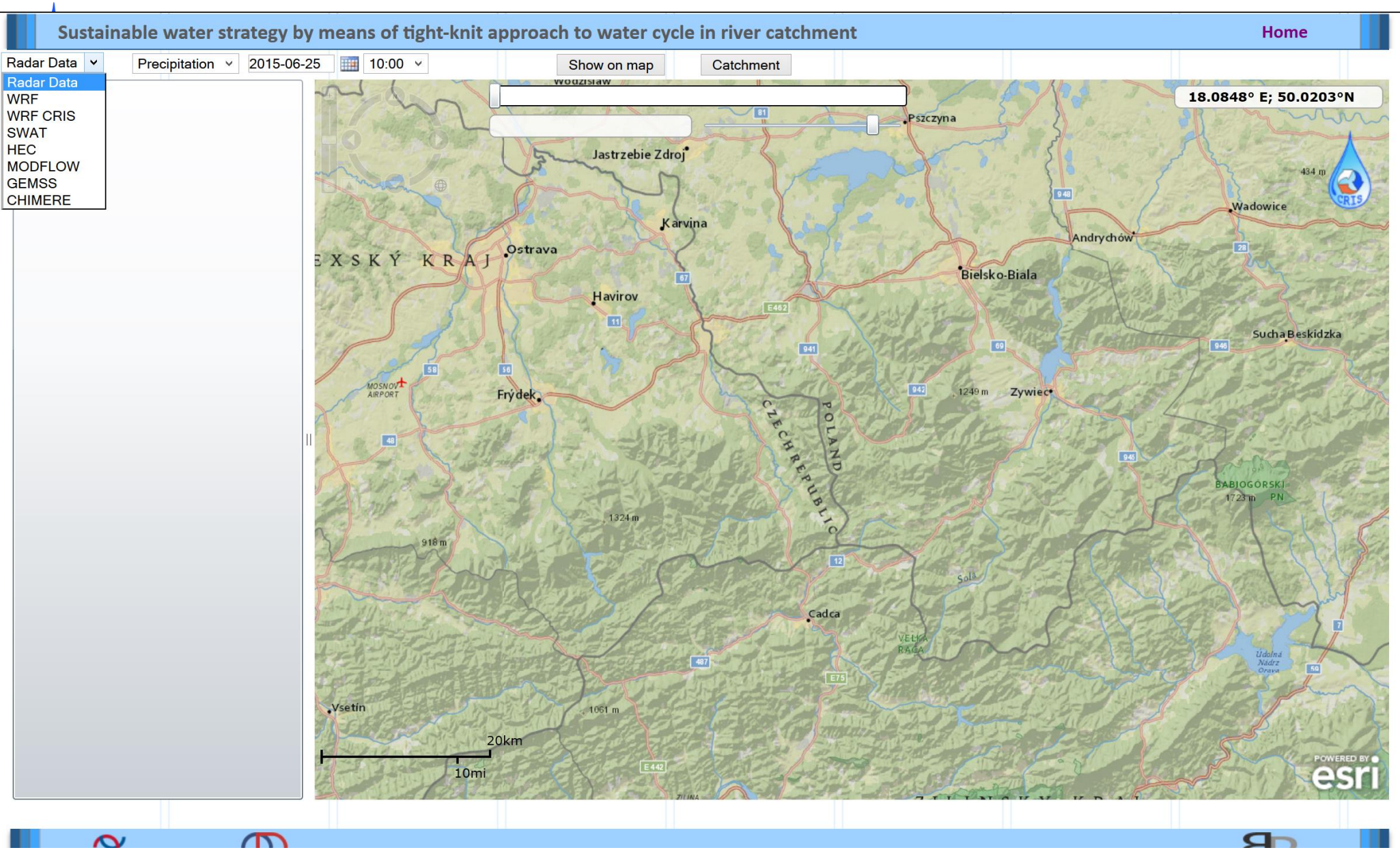
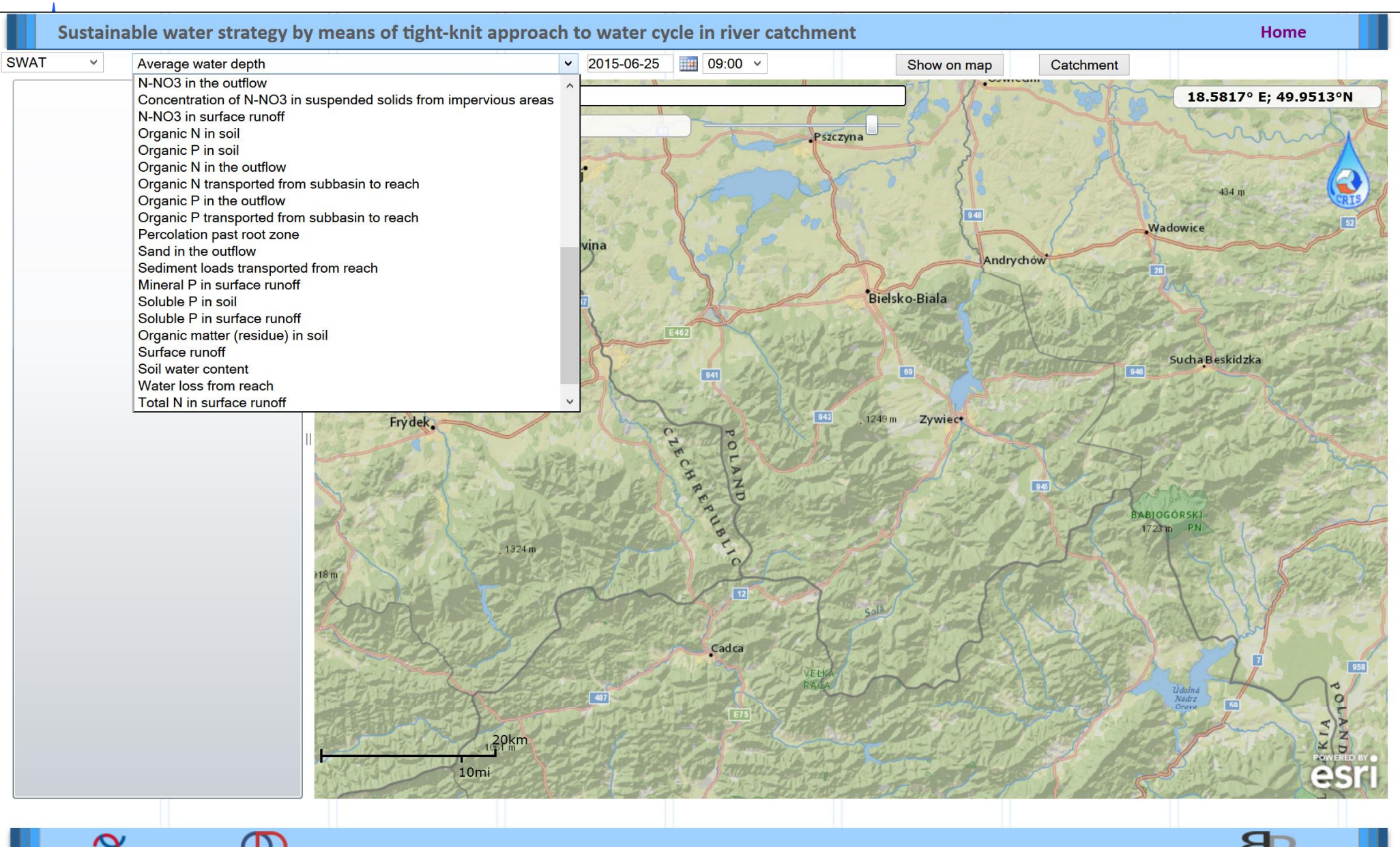


CRIS information system – SWAT outputs



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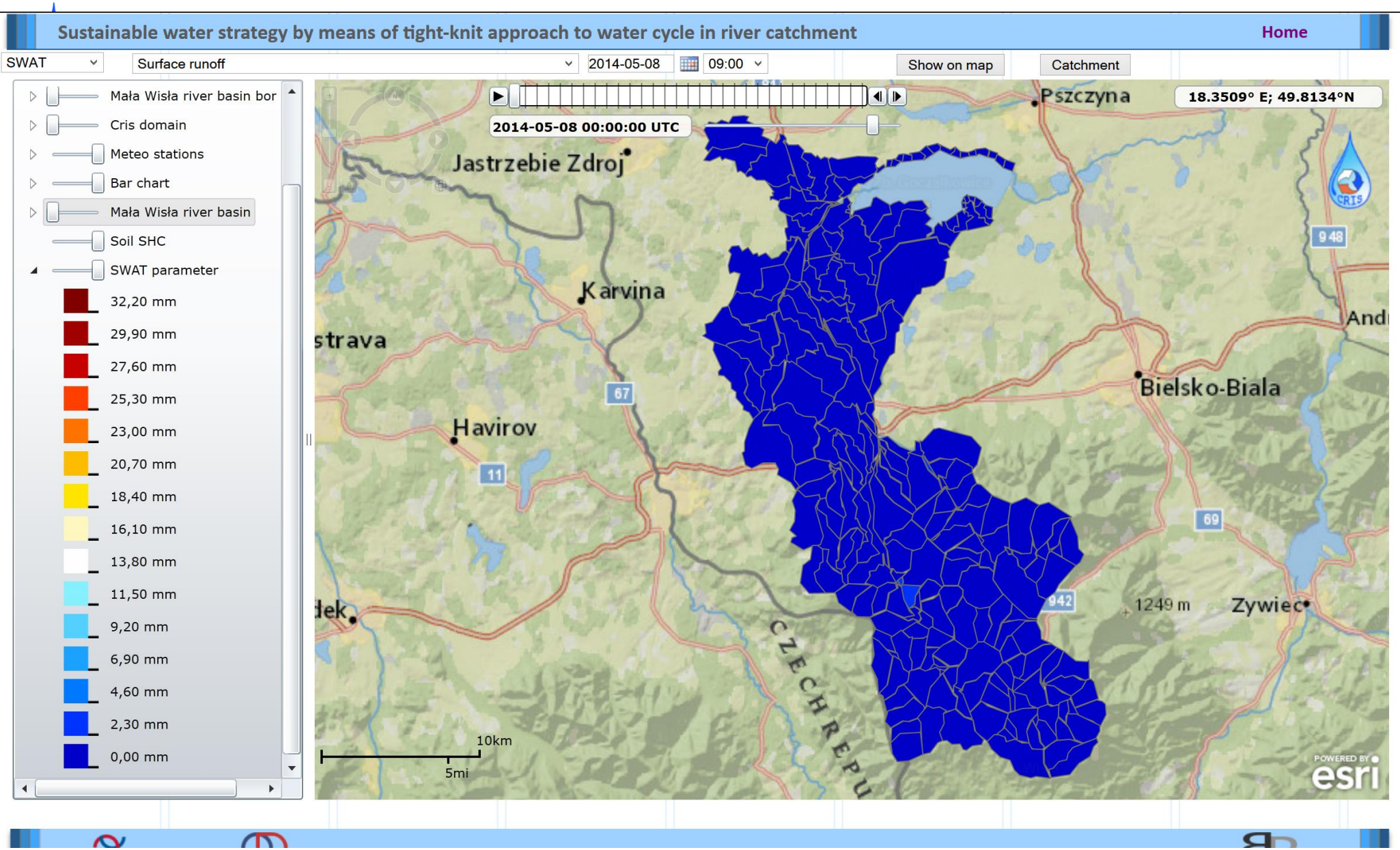
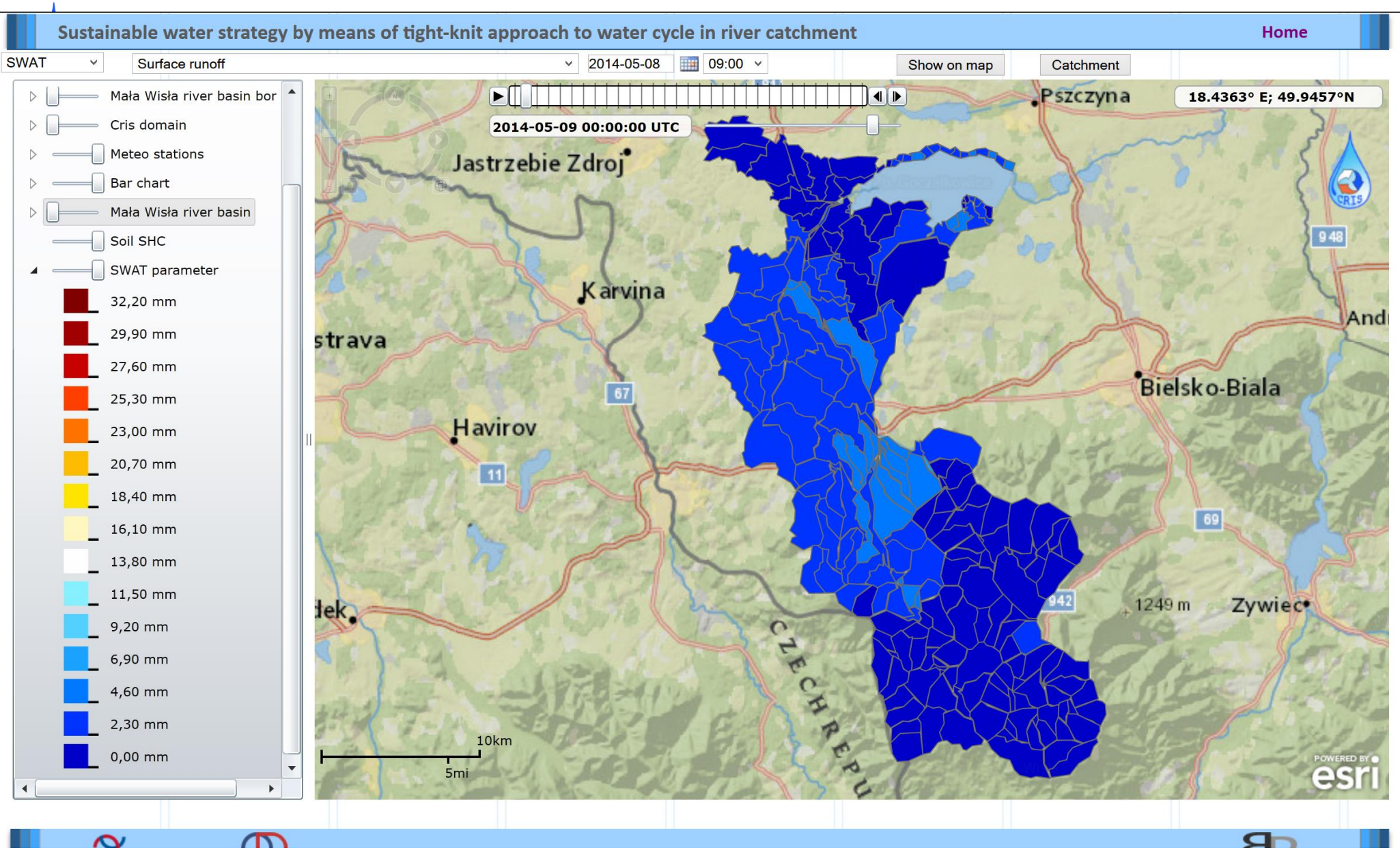
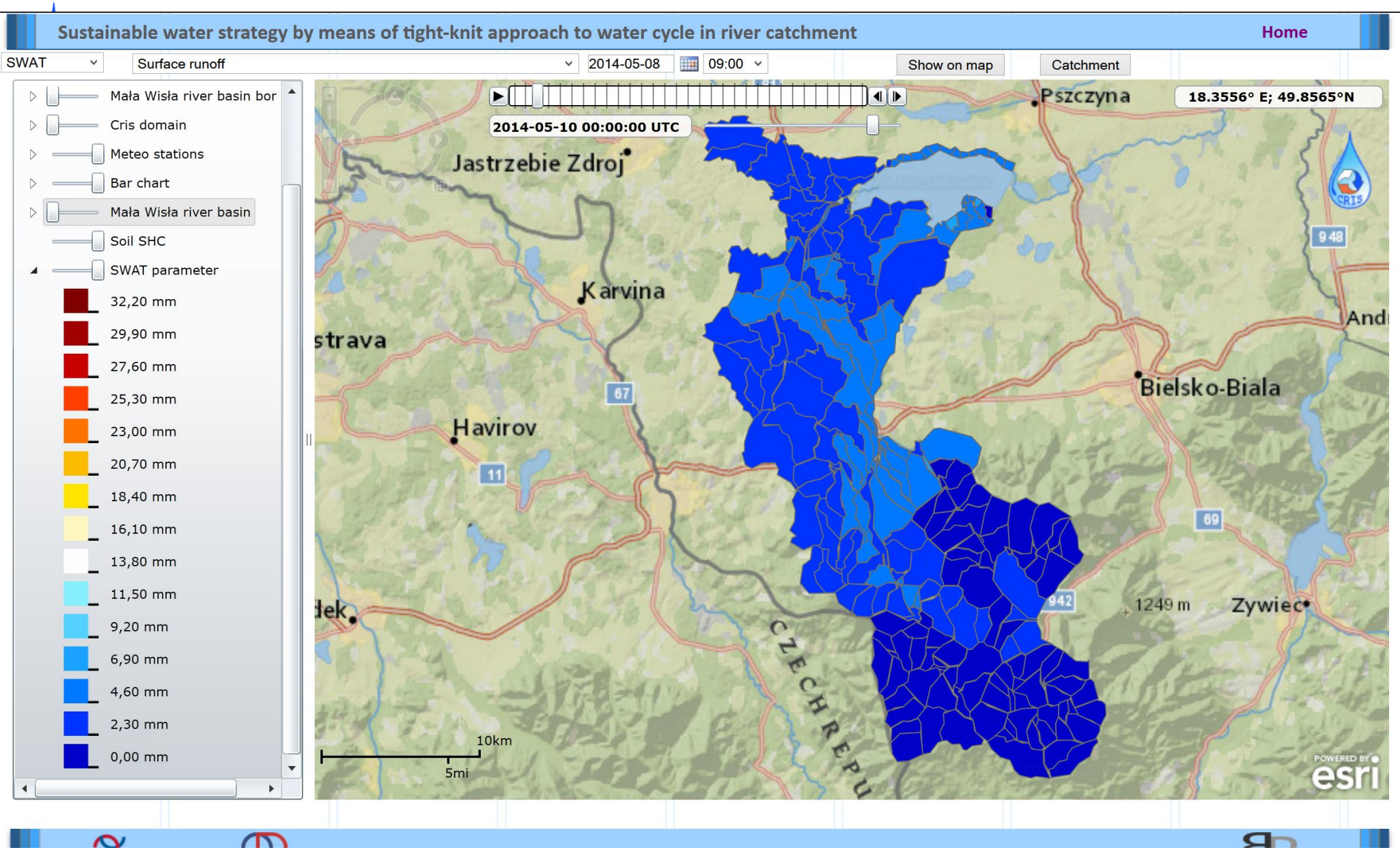


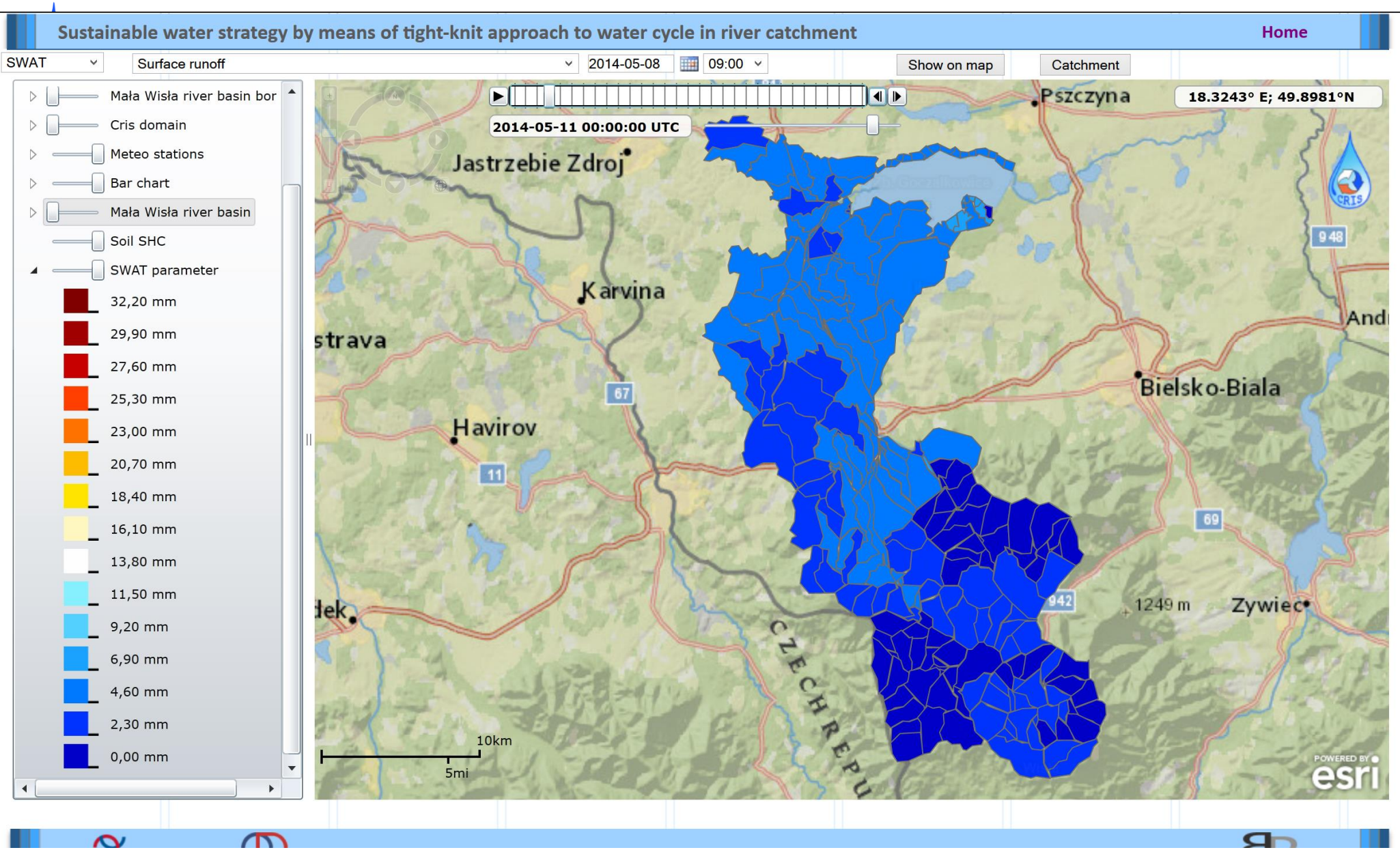
CRIS information system – SWAT outputs (surface runoff)



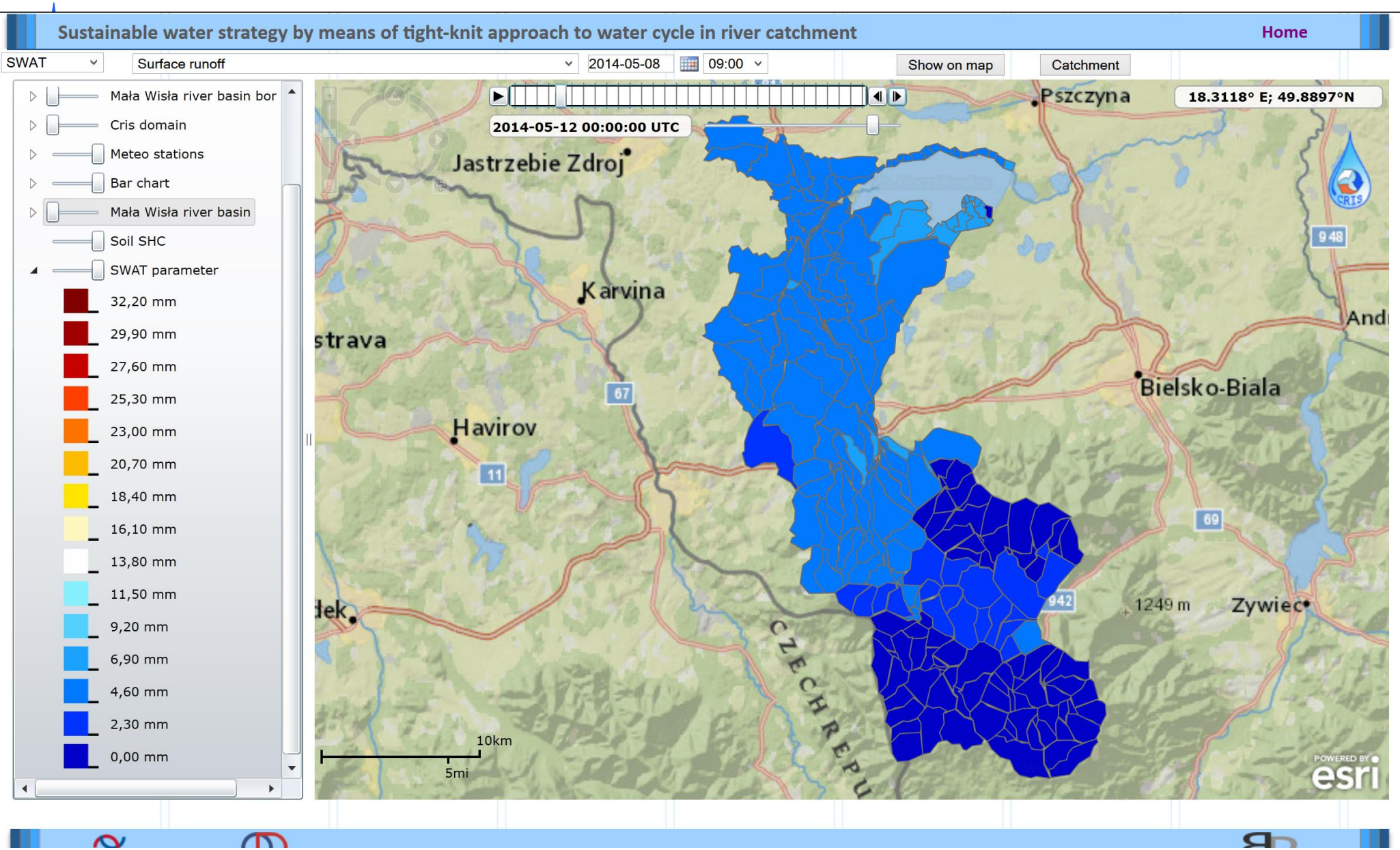
CRIS information system – SWAT outputs (surface runoff)



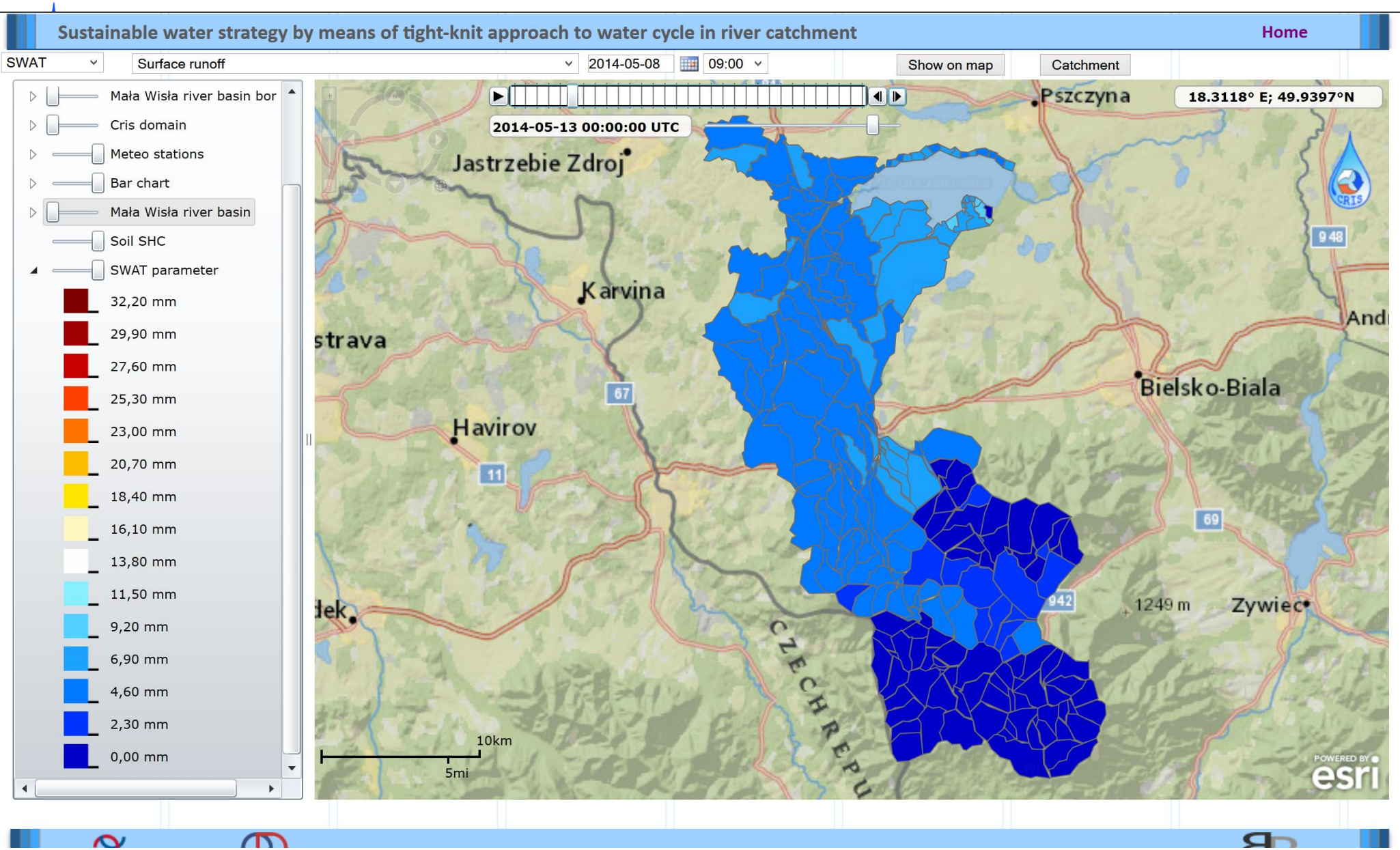
CRIS information system – SWAT outputs (surface runoff)



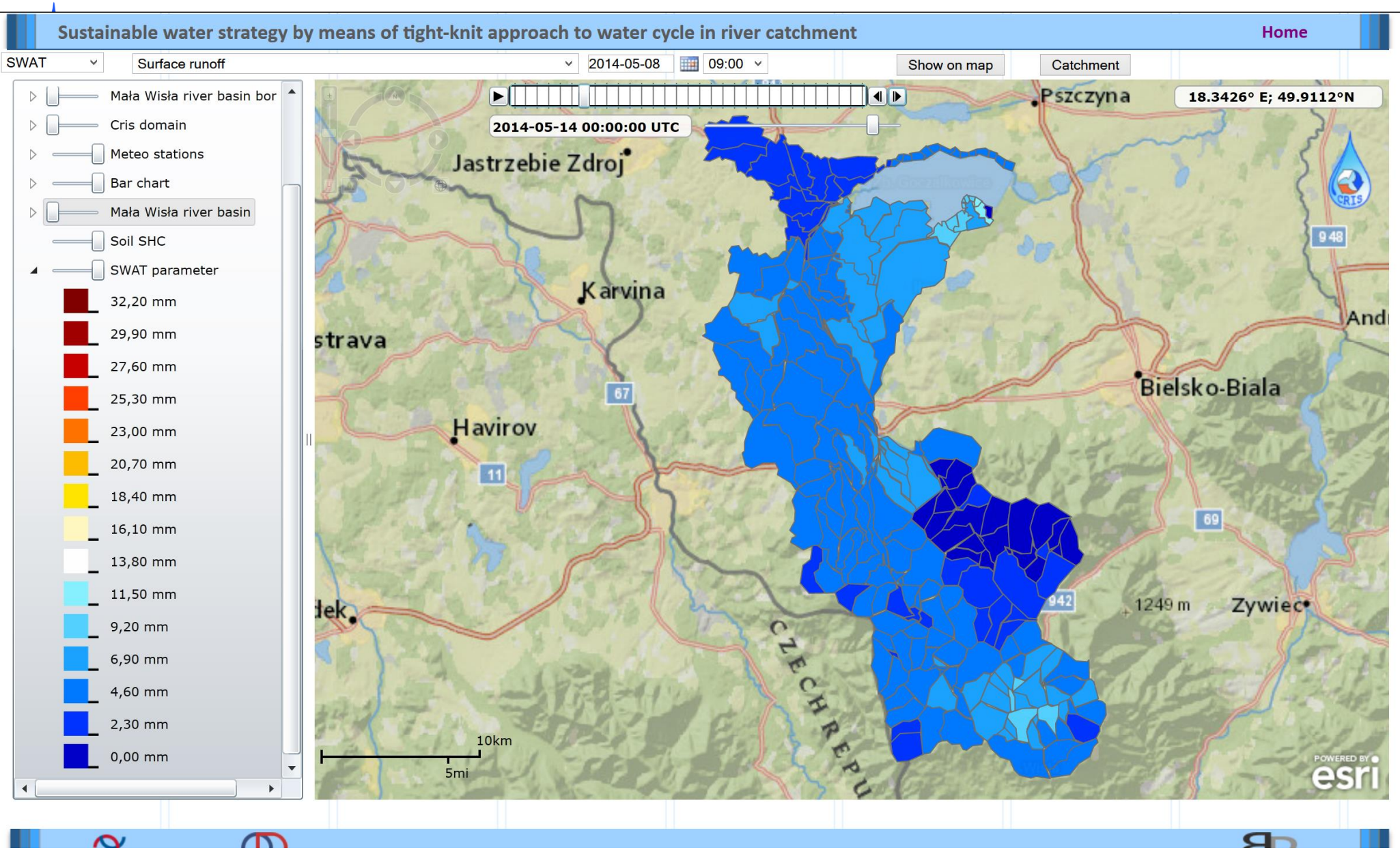
CRIS information system – SWAT outputs (surface runoff)



CRIS information system – SWAT outputs (surface runoff)



CRIS information system – SWAT outputs (surface runoff)



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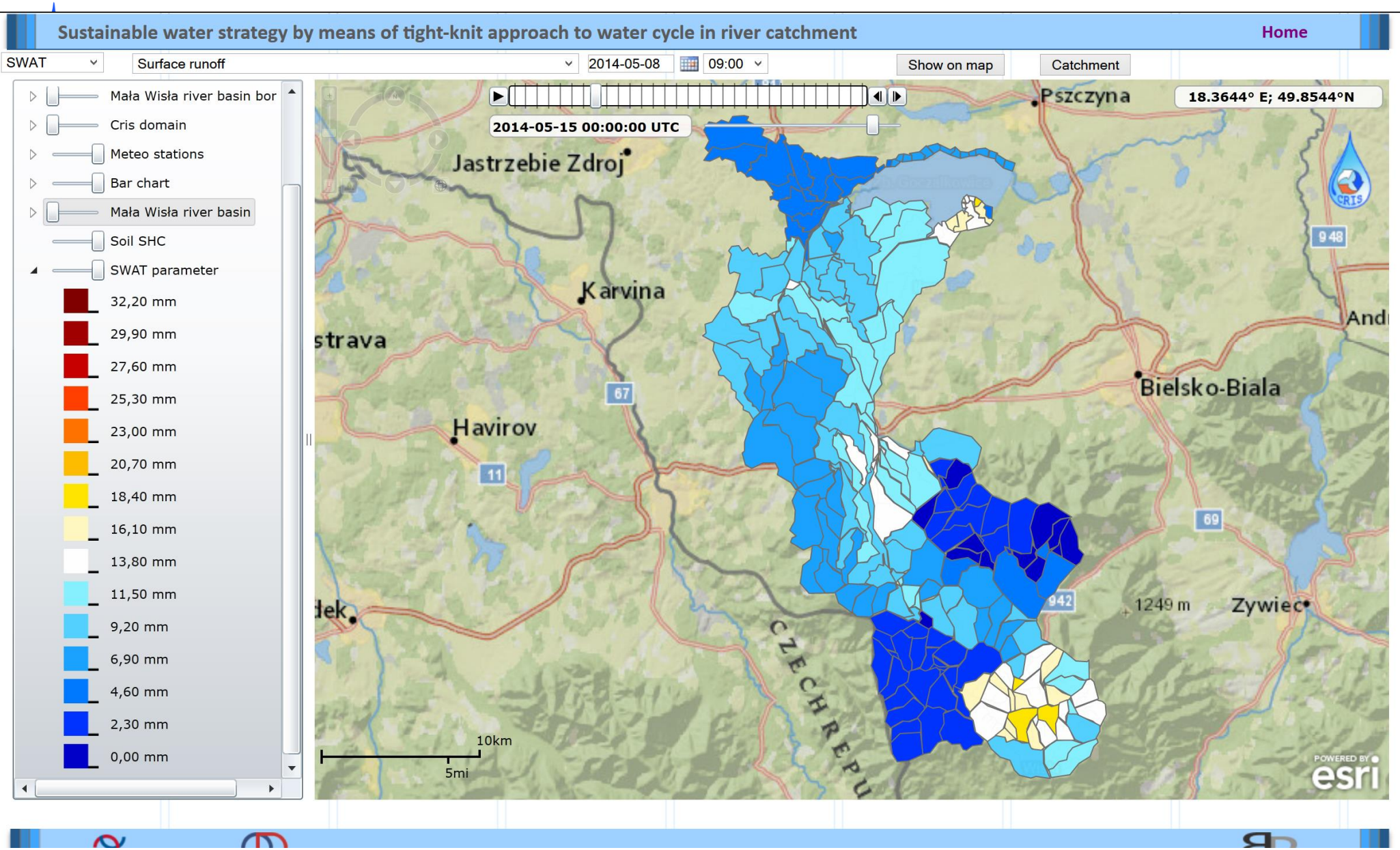

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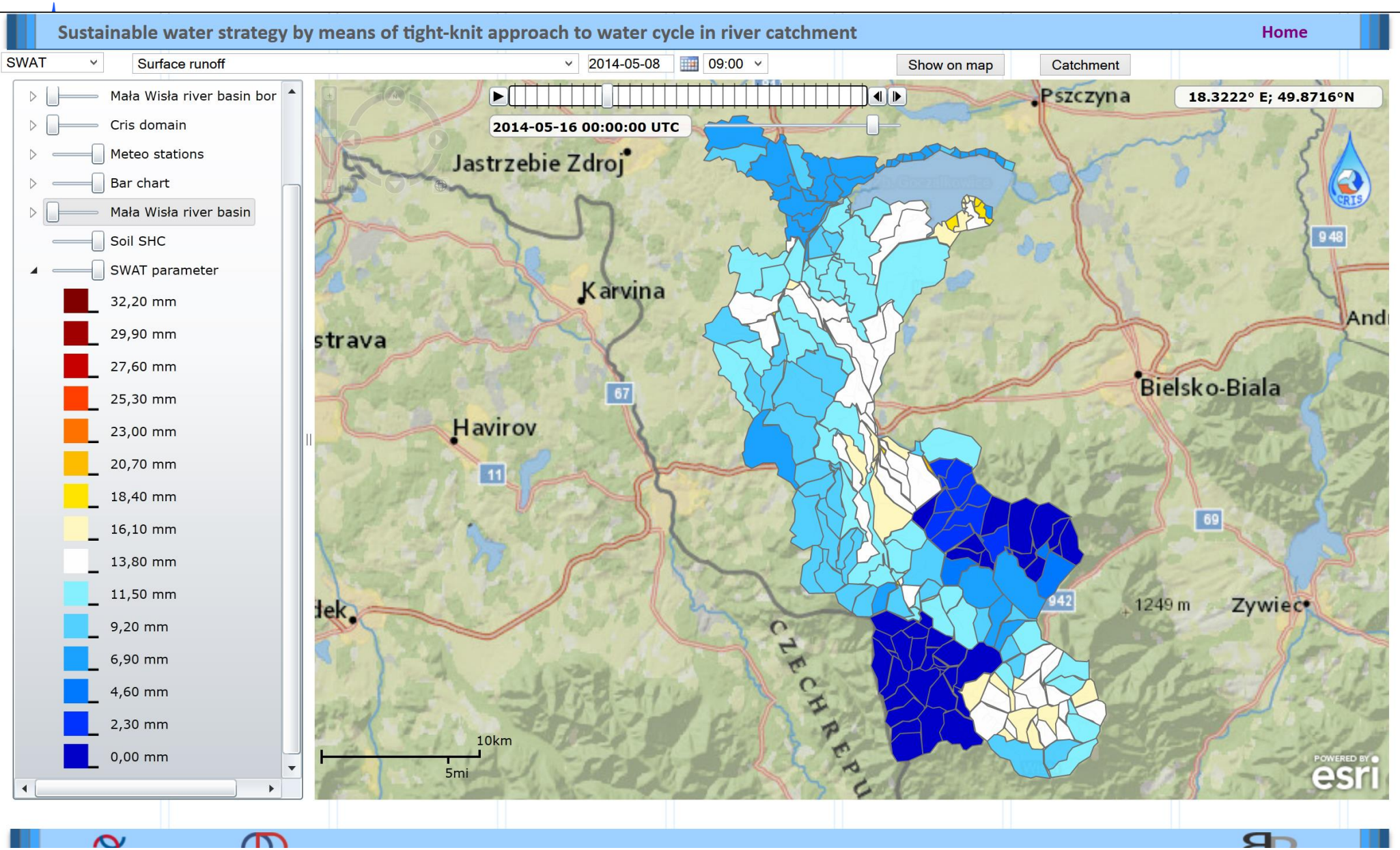

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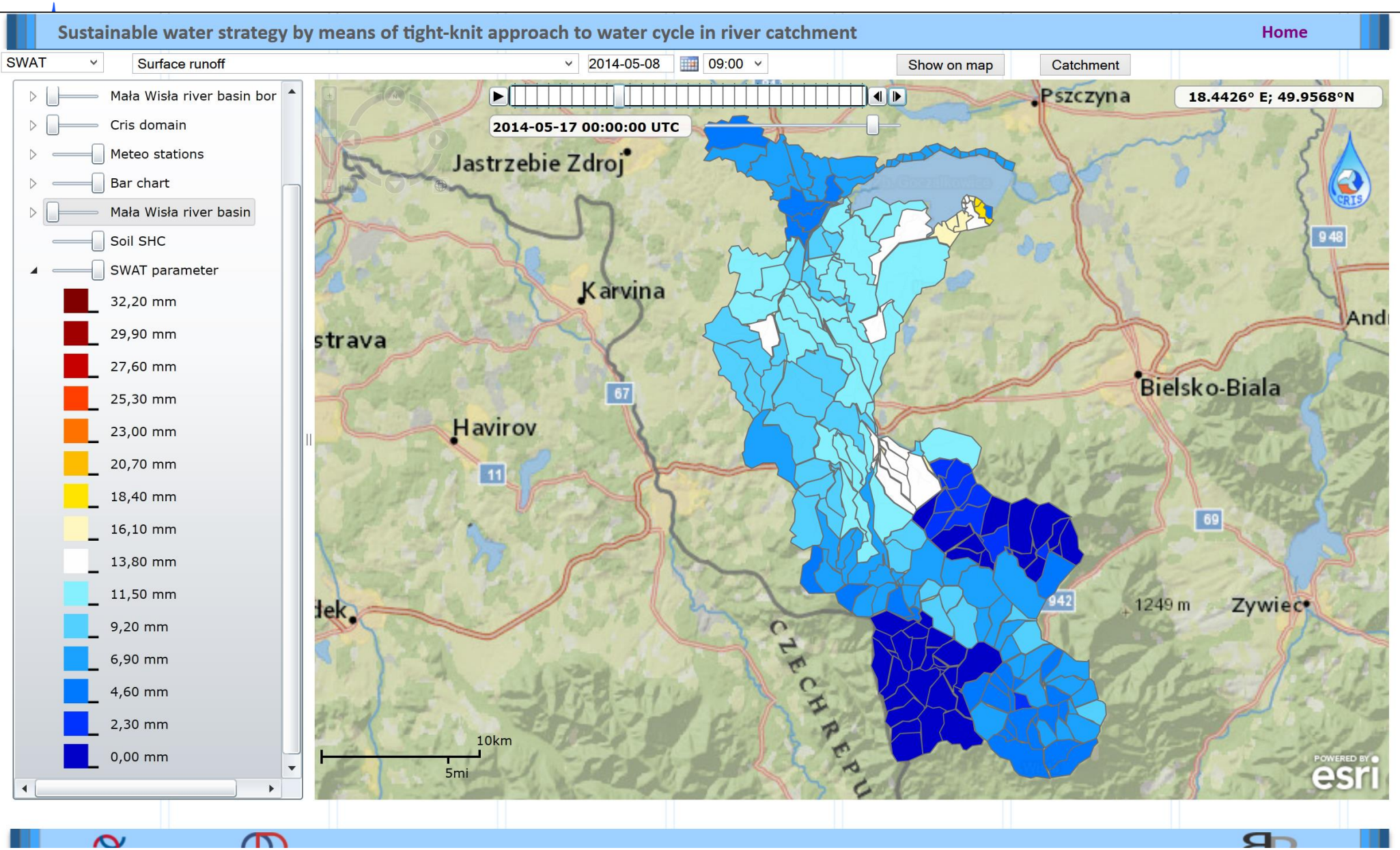

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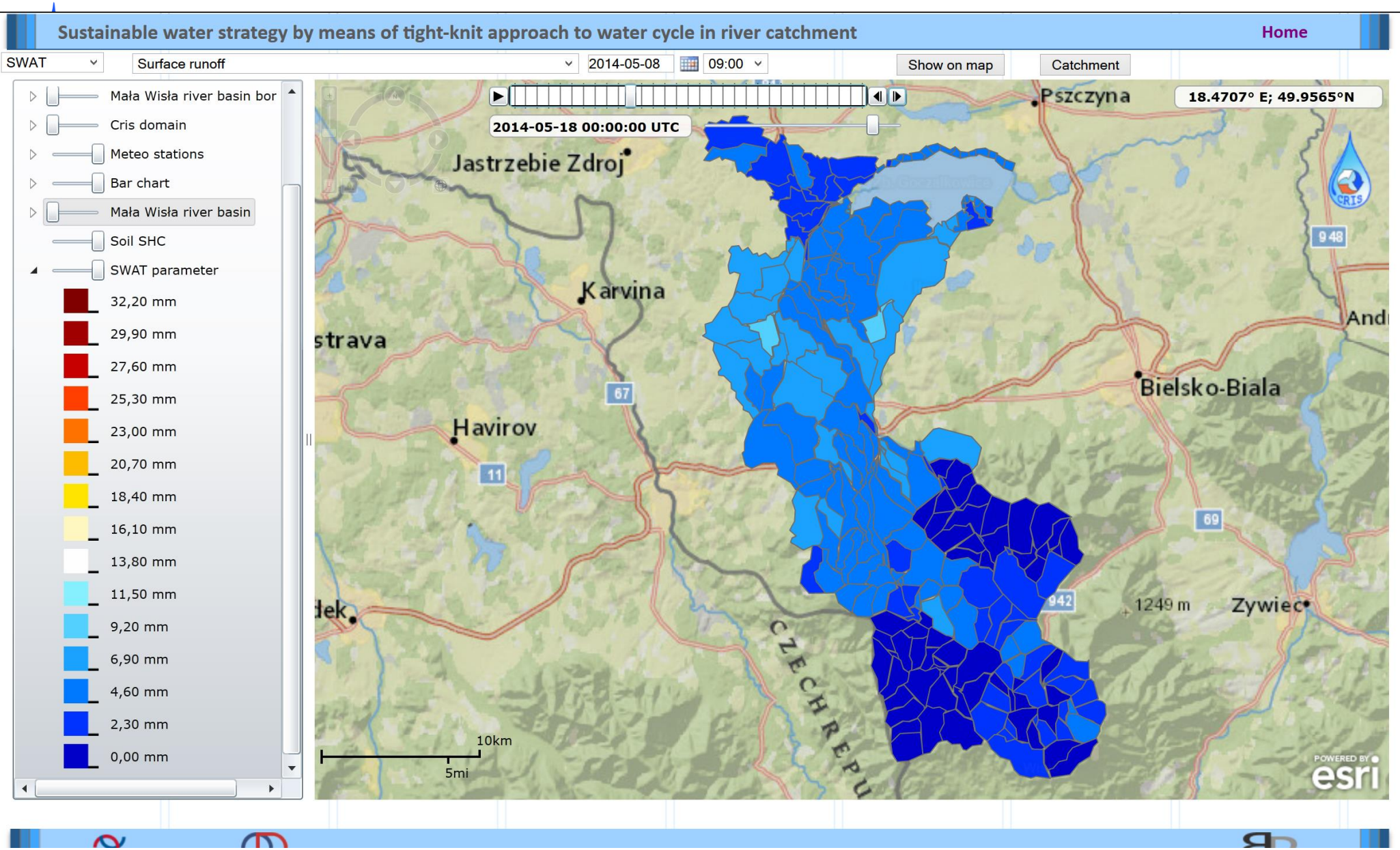

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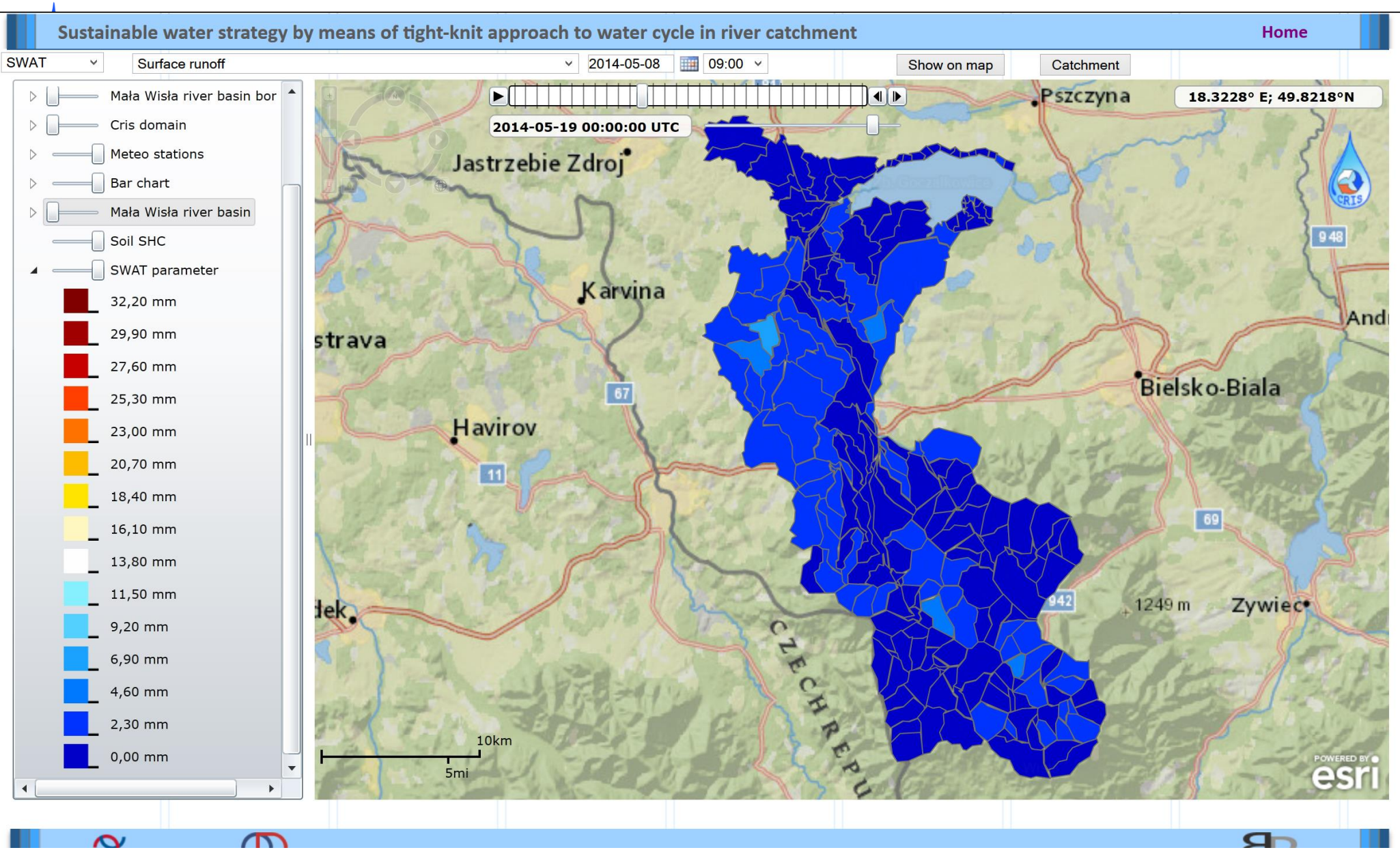
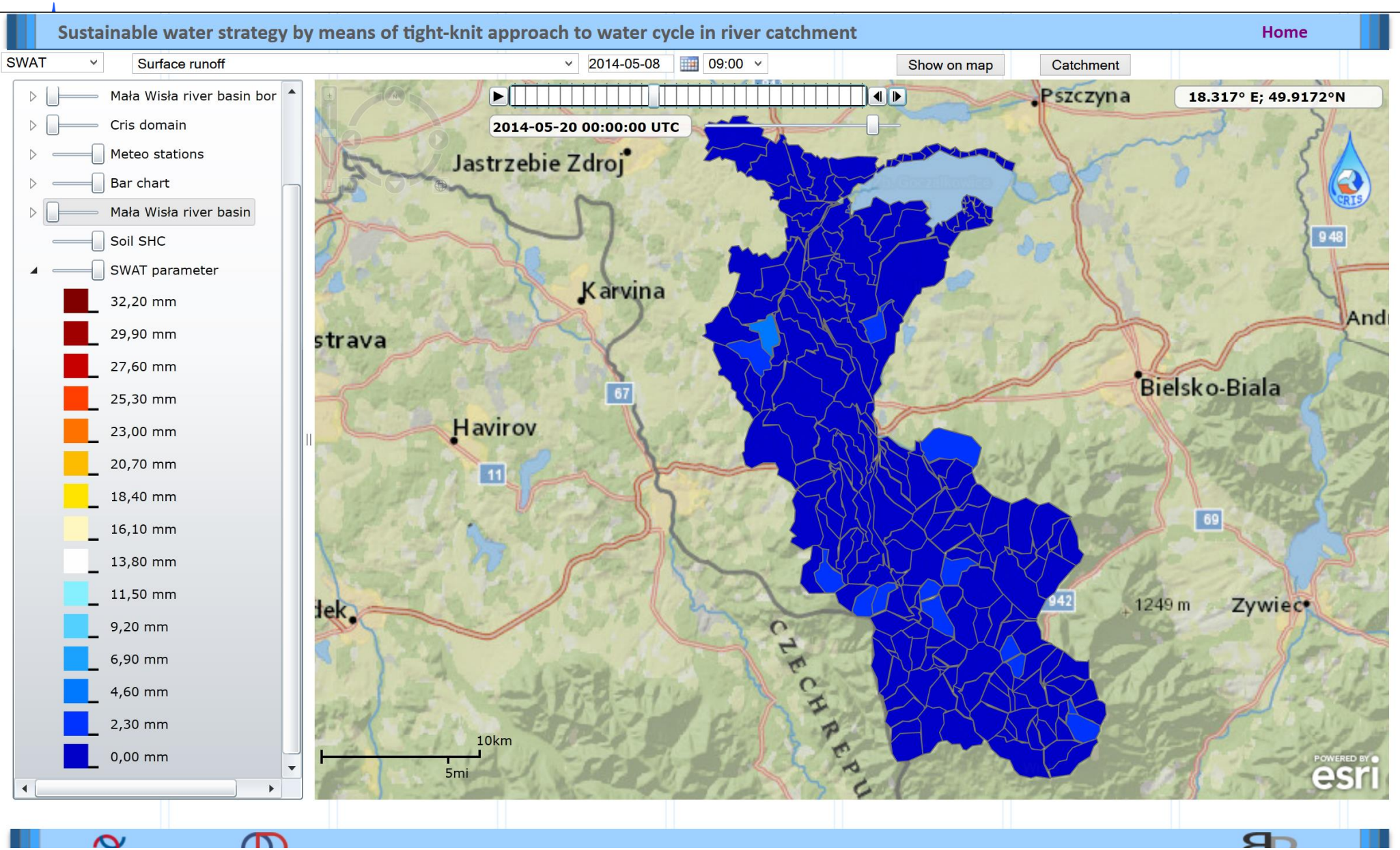
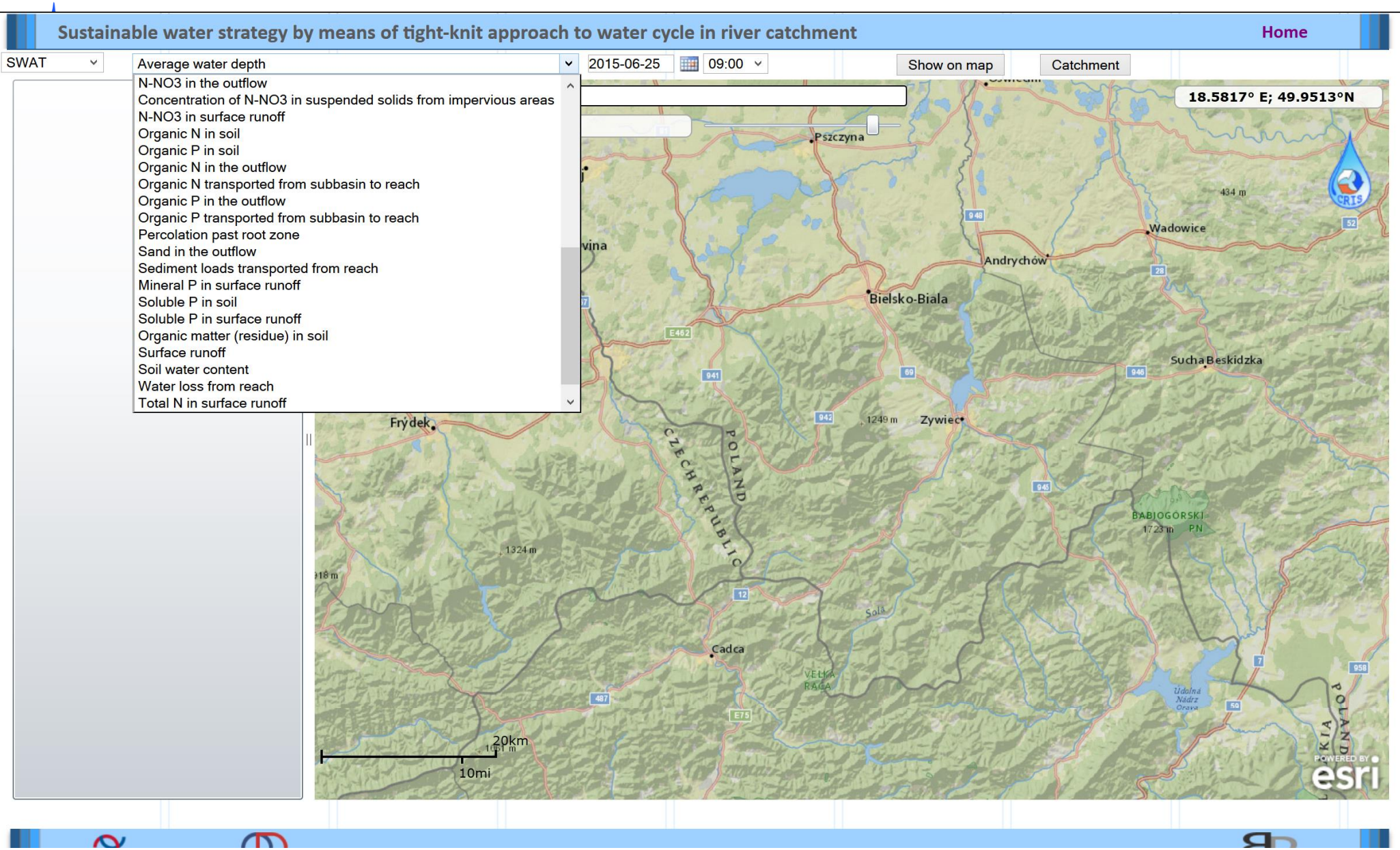


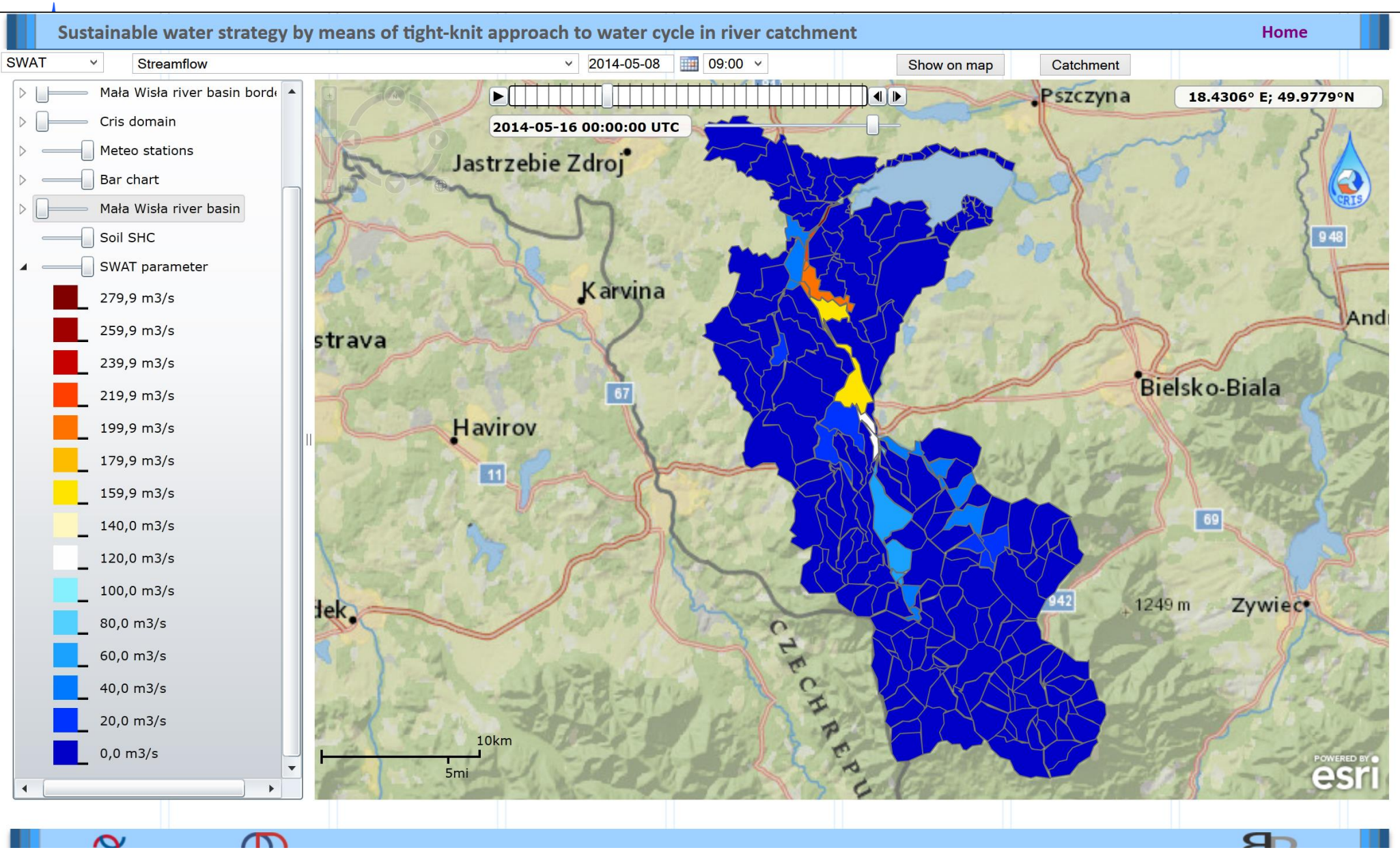
CRIS information system – SWAT outputs (surface runoff)



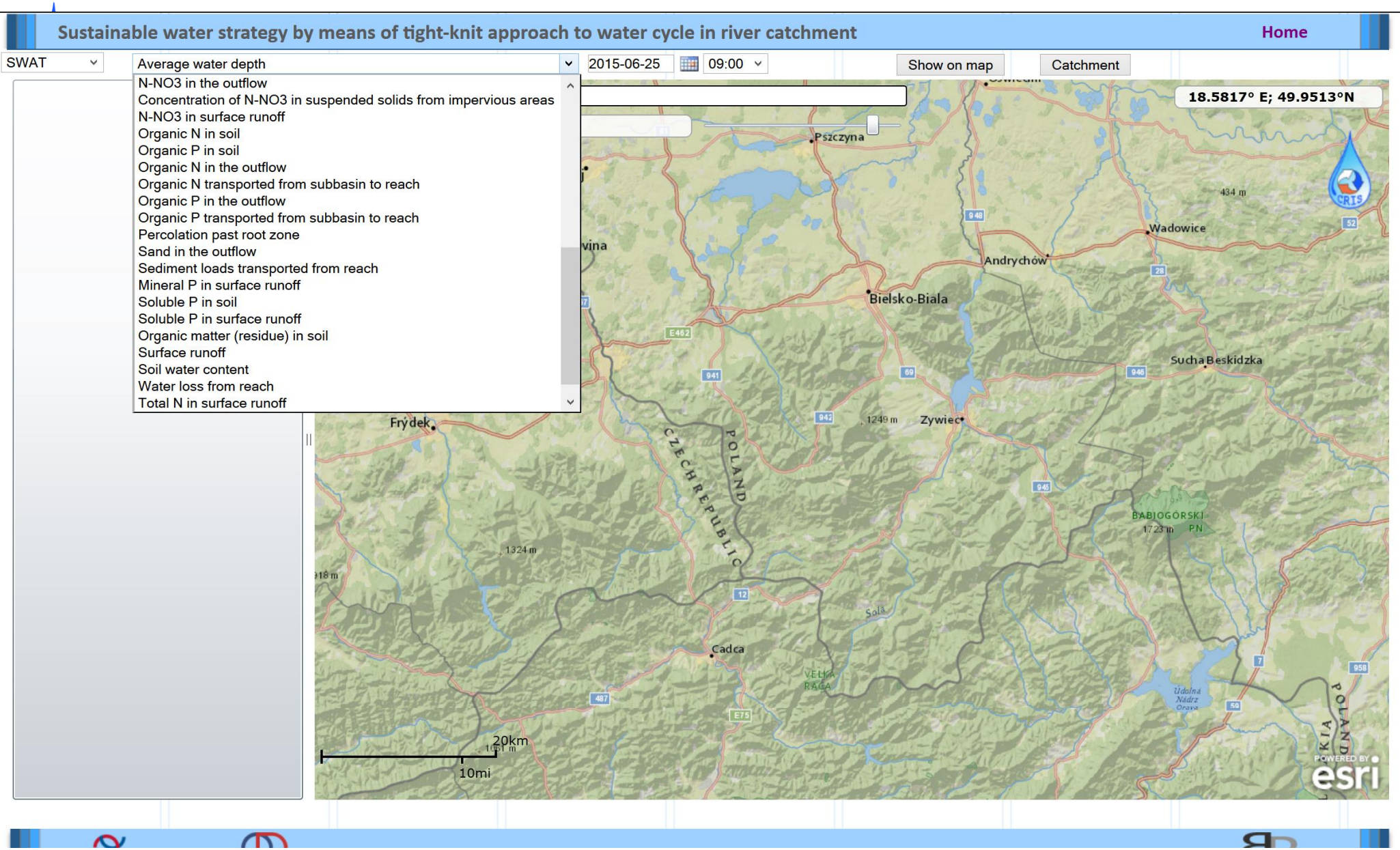
CRIS information system – SWAT outputs (surface runoff)



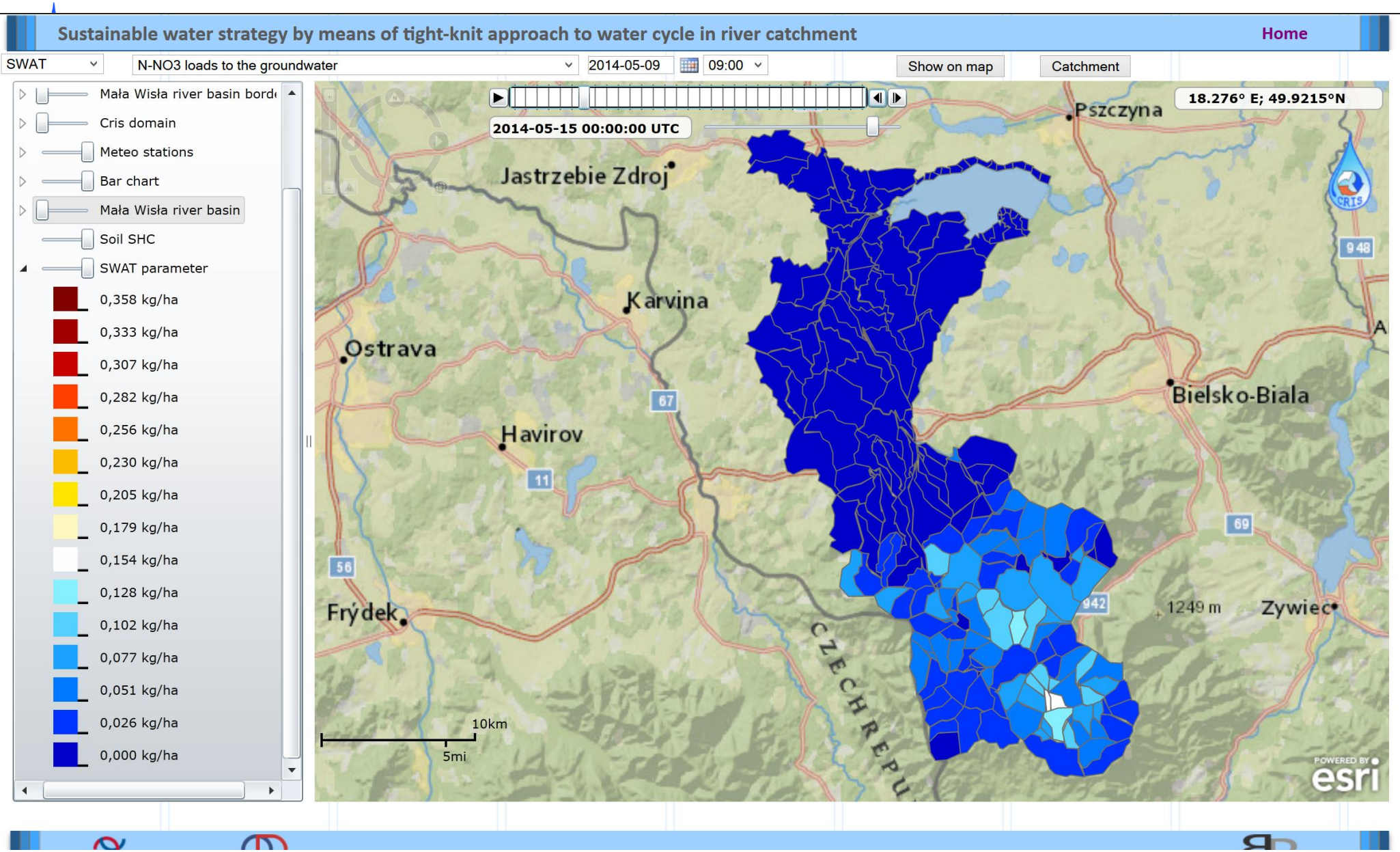
CRIS information system – SWAT outputs (stream flow)



CRIS information system – SWAT outputs (stream flow)



CRIS information system – SWAT outputs (NO3 in recharge)



CRIS information system – SWAT outputs (NO3 in recharge)

SWAT in the CRIS project

Sustainable water strategy by means of tight-knit approach to water cycle in river catchment

About project | Case study area | Consortium | Contact | Downloads | Polski

- Introduction
- Objectives
- Work programme

Cris > About project > Objectives

Objectives

The main aim of the project is to develop the information system supporting the river basin management. The information service will support units responsible for water management by providing them with the detailed real-time and short-term forecasted information on:
– distribution of the precipitation,
– flow rate and water level in streams,

www.cris.ietu.katowice.pl
(key words: CRIS IOS, CRIS IETU, CRIS NIVA)